

November 19, 1962

**SPECIAL REPORT:**

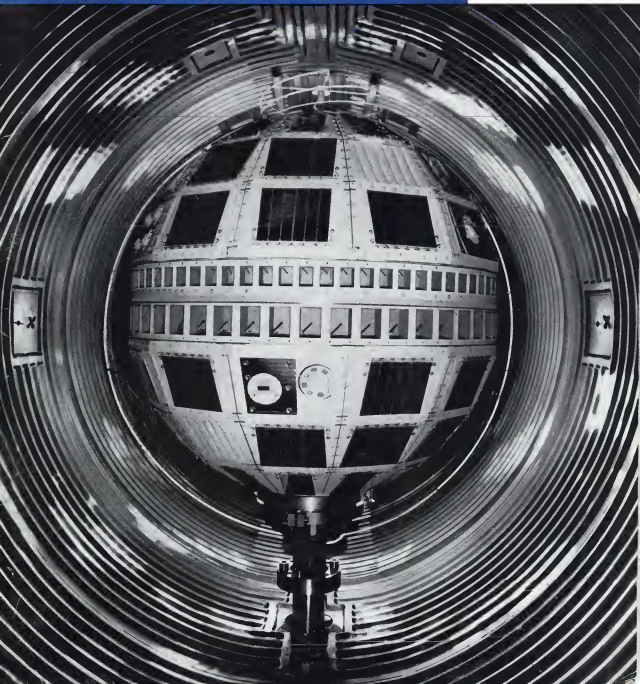
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## AEROSPACE CALENDAR

- Nov. 26-27—Western States Section Meeting, The Combustion Institute, Aerojet-General Corp., Azusa, Calif.
- Nov. 26-28—Annual Combined Meeting American Nuclear Society, Atomic Industrial Forum and Joint American Rocket/Fuel and Rocket Motor, Washington, D.C.
- Nov. 27-29—90th Meeting, American Defense and Manufacturing Assn., The Ritz-Carlton, Miami Beach, Fla.
- Nov. 27-29—4th Meeting, Radio Technical Committee for Aeronautics, Marriott Motor Hotel, Washington, D.C.
- Nov. 28-30—1968 Ultrasonic Symposium, Institute of Radio Engineers, Columbia University, New York, N.Y.
- Dec. 24-1968 Annual International Air Safety Seminar, Flight Safety Foundation, Williamsburg, Va. (ISF members and by invitation)
- Dec. 44—Full Joint Computer Conference, Sheraton Hotel, Philadelphia, Pa. Sponsored American Federation of Information Processing Societies, AFIPS
- Dec. 44-1968 Convention, National Aeronautics Assn., Flamingo Hotel, Las Vegas, Nev.
- Dec. 1-12—Annual National Air Traffic Conference, Flamingo Hotel, Las Vegas, Nev.
- Dec. 5—Annual Director Meeting Strategic Information Assn., Sheraton Hotel, Las Vegas, Nev.
- Dec. 6-10—Annual Communications Conference, Sheraton Hotel, Las Vegas, Nev.

(Continued on page 7)

## AVIATION WEEK and Space Technology

November 19, 1962  
Vol. 37, No. 31

The primary aim of this publication is to provide a comprehensive and authoritative source of information on the latest developments in aviation and space technology. It covers a wide range of topics, including aircraft design, engine development, space exploration, and military applications. The publication is published weekly, except for two issues combined annually in November and December. It is a valuable resource for engineers, scientists, and anyone interested in the latest advances in aviation and space technology.

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## AEROSPACE CALENDAR

(Continued from page 5)

Forming RSE, Darryland Hotel, Los Angeles

Dec. 10-11-First Annual Symposium on Unconventional Aerial Section (Joint with Republic's Paul Henry Research & Development Center, Farmville, N. Y.)  
Casper, N. Y. - American Rocket Society and American Association for Advancement of Science, Philadelphia, Pa.

Dec. 10-12-Conference on VTOL Aircraft, New York Academy of Sciences, Henry Hudson Hotel, New York, N. Y.

Dec. 10-12-Annual Physics Meeting, American Rocket Society and American Association for Advancement of Science, Philadelphia, Pa.

Dec. 21-American Astronautical Society Symposium on Scientific Staffing-Mission and Design, Franklin Hotel, Philadelphia

Jan. 7-10-1968-Annual Meeting of the Institute of Radio Engineers, Coney Plaza Hotel, Orlando, Fla.

Jan. 13-14-1968-Annual Convention, Helicopter Association of America, Delmonico Hotel, Palm Beach, Calif.

Jan. 14-15-1968-International Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 21-21-1968-Annual Meeting (including Wright Brothers Lecture), Institute of the Aerospace Sciences, Hotel Astor, New York, N. Y.

Jan. 21-24-1968-Annual Meeting, American Micrological Society, New York, N. Y.

Jan. 22-24-1968-North Atlantic Symposium on Reliability and Quality Control, Sheraton Palace Hotel, San Francisco, Calif.

Jan. 24-24-1968-Annual Army Aviation Conference, American Rocket Society, International Inn, Washington, D. C.

Jan. 24-24-1968-Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Sheraton Hotel and The Franklin Institute, Philadelphia

Jan. 24-24-1968-Annual Winter Conference on Military Electronics, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Feb. 1-1-1968-Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Ga.

Feb. 1-1-1968-Tenth International Symposium on Quantum Electronics, UNESCO Building, Paris, France

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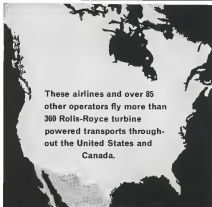
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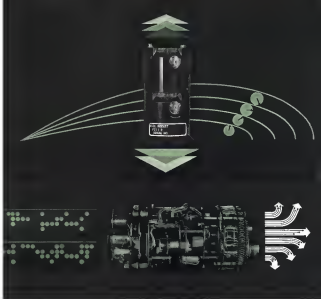
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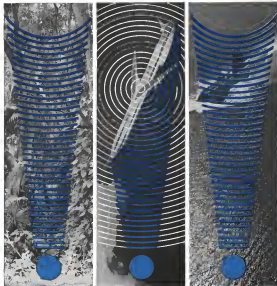
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## Aviation Week & Space Technology

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COVER: Bell Telephone Teler 2 is prepared for environmental testing in company's space chamber. Photo was taken before closing of access door on one end of the cylindrical chamber. Three solar panels protrude profile along right edge into chamber. Rough Pyrex windows, preheating valves and shieldable switches protruding under access window. National Carbon Co. furnished the air cylinder. During test, Teler was suspended from hooks.

COVER: Joseph E. Bell Telephone Teler 2 is prepared for environmental testing in company's space chamber. Photo was taken before closing of access door on one end of the cylindrical chamber. Three solar panels protrude profile along right edge into chamber. Rough Pyrex windows, preheating valves and shieldable switches protruding under access window. National Carbon Co. furnished the air cylinder. During test, Teler was suspended from hooks.

## NASA Growing Pains

The National Aeronautics and Space Administration shows signs of suffering from acute growing pains in the Fiscal 1964 budgeting season begins. There are solid indications that the Apollo manned lunar landing program is already beginning to slip due to financial strain (AW Nov. 12, p. 27), and further significant slippage may be expected unless its funding is increased. Already, other aspects of NASA's rightfully broad space exploration program are being pinched to provide funds for the Apollo program, and the strain in these areas will grow acute if present funding plans don't change.

It is not unusual that an organization that has grown as fast as NASA during the past two years should be suffering from growing pains and budgetary strain. Almost from its inception, NASA has shown a trend toward cost inflation, underestimating the cost requirements of its major technical programs. For example, the cost of the Mercury manned orbital space flight program has quadrupled over the original cost estimate made by NASA. One major phase of Mercury actually cost 10 times the original price tag. The Apollo program and many other key NASA ventures are already showing signs of climbing this same curve of rising costs. This is seriously disturbing to the program managers who are charged with pushing us toward their technical goals at full speed, to the NASA administrators who assure Congress that their funding budget scope was sufficient to achieve desired goals without maximum time spans, and to the congressmen who have supported NASA programs and budgets because of the assurance that they met the high priority goals established by President Kennedy some 18 months ago. But it is really no inevitable byproduct of any major effort to push hard along a major technological frontier and gain basic new knowledge.

### Funding Needs Misunderstood

It is also one of the tragedies of our time that the vital funding requirements of major research and development efforts are so poorly understood by the fiscal officers who control the budgeting process. As a nation, we have wasted far more money in the unfulfilled funding techniques used to support research and development than we have through the saving costs of those programs as they reach the pay-off stage. These shortsighted policies, based on short-term financing techniques, have developed far more drag on the long-term goals of research programs than any technical obstacle. They have been particularly acute in the development of new military weapons systems during the past decade and they now threaten to develop the same bureaucratic fiscal drag on the national space program.

When a nation sets its technical sights as far out as we have in our entire space technology program and particularly in the manned lunar landing program, it is impossible to estimate accurately the eventual cost of this effort at its inception. No blame should attach to anyone or any agency for the failure to do so, although

it won't be long before the General Accounting Office and the Resignation Board, with their 70-20 hindsight, will begin to criticize someone on this score.

The real problem presented by the growing pains of the space agency is its approach in the Fiscal 1964 budgeting process in whether it is going to stick to the technical performance goals and timetable it set for the Apollo program and other key space exploration efforts and ask for the resources necessary to do the job, or whether it is going to begin the process of tinkering its technical goals to fit a budget ceiling. There is no doubt that if President Kennedy is still serious about boosting the nation into pre-eminent in space technology, and beating the Soviets to the moon as the first tangible proof of that leadership, there will be strong resource requirements for the Apollo program program. It is also equally clear that if funding limitations are to be imposed before the rate that maximum technical program sequence, there can be little hope of achieving this leadership.

### Space Program Definition

The real essence of the debate that is certain to ensue over NASA's Fiscal 1964 budget level is what kind of a space program the nation really wants. Does it want a maximum effort to beat the Soviets to a manned lunar landing and establish U. S. leadership in space technology and not a willingness to just be well managed effort toward this goal? Or does it want a more moderately paced effort, geared to budget ceilings rather than technical programs, and is it willing to sacrifice the chance to achieve international leadership to gain at least the chance of financial stability and orderly bookkeeping?

We think that the Kennedy Administration, the Congress and the American people will have to make that decision when they handle the Fiscal 1964 budget for NASA. In making that choice it is important that all of the facts involved are discussed in the debate that is being held. It will serve as a useful national purpose to try to conceal the fiscal realities of a strong space program that can push forward as fast as its technical program allows. And it will serve no useful purpose for NASA officials to make anything but the fact that they are getting all the money that can be "usefully spent" when the technical people at the working levels are being decelerated by fiscal brakes.

After the manner in which the news of the Cuban missile crisis was quickly controlled to produce a calculated political effect, all agencies of the government necessarily must be suspect of managing the news to suit their current purposes. Industry, Congress and the American people should be particularly alert to the unfolding of the national space policy debate, and expend extra effort to ensure that the issues are candidly presented and the alternatives clearly outlined so that an intelligent decision can be made.

—Robert Hotz

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Astrodata ECAN modules accept signals from virtually all types of instrumentation transducers. They can operate with hundreds of test of input lines and provide high output currents to drive galvanometers, or more than a mile of transmission lines. High performance characteristics—low noise, broad bandwidth and high speed overload recovery—permit time sharing, multiplexing. Floating isolation power supplies are furnished to isolate individual channels.



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## WHO'S WHERE

### In the Front Office

**James S. Lee**, sales manager, **Proft & Wilson**, AeroSpace Division of United Aircraft Corp., Box 1000, Hartford, Conn. 06101, is president of the firm. **C. J. McKinnon**, Robert Shaw, vice president, and **John E. Lee**, president of United Aircraft International, a subsidiary of UAC. Also, **Robert M. Edwards**, executive vice president, and **George Egan**, a vice president of United Aircraft International.

**Regina A. Holman**, RMC, vice president and general manager, Sonosensor Division of Hoffman Electronics Corp., Los Angeles, Calif., according to Vice President **Theodore S. Holman**, sonosensor manager.

**Robert A. Wilson**, vice president and general manager, General Dynamics/Kollsman, Hawthorne, N.Y.

**Spaul Technology Laboratories** is a subsidiary of Thompson Ramo Wooldridge, Inc., Redondo Beach, Calif. Its chief executive officer is **Robert D. DeLoach**, executive director. **Edwin M. DeLoach**, program manager and director of SFL's Space Weapons Program office, **Edward M. DeLoach**, SFL program and director of corporate planning and control, **Dr. George R. Solomon**, director, Systems Research and Analysis Division.

The Secretary of Defense has announced the following appointments to the Defense Communications Agency: **May Gen. John E. Farris**, USAF, Deputy Director, Defense Communications Agency; **Brig. Gen. George P. Simpson**, USAF, Deputy Director, Defense Communications Agency; **Brig. Gen. John E. Farris**, USAF, Deputy Director, Defense Communications Agency; **Brig. Gen. John E. Farris**, USAF, Deputy Director, Defense Communications Agency.

### Changes

**Dr. Edgar A. Sack**, Jr., engineering manager, **Winghouse Molecular Electronics Division**, Princeton, N.J.

**Dr. Robert H. Bagg** and **Dr. Thomas R. Telford**, both senior research associates of Lockheed Martin & Space Co.'s Materials Research Laboratory, Palo Alto, Calif.

**Dr. Harry J. Werten**, chief design engineer, **Lockheed Engineering Research & Development**, Palo Alto, Calif.

**Robert G. Brown**, assistant vice president, **AC Spark Plug Division** of General Motors, Warrendale, Pa., according to **Paul D. Jones**, vice president, Division 3 Program.

**Dr. E. E. Brown**, senior design engineer, **Thompson Submarine Systems**, Hawthorne, Calif.

**Ed G. Nadel**, manager of contract administration, **South Aircraft Corp.**, Wichita, Kan., and also weapons systems manager for **Boeing's** subsonic program on the **McDonnell Douglas F-15**.

**James H. Langford**, director, Bureau of Safety, Civil Aeronautics Board, Washington, D.C., and **Robert R. Allen**, deputy director, **John Wiley & Sons**, executive assistant to the director.

**Jack S. Rappaport**, manager general development, **Lockheed Georgia Co.**, Marietta, Ga., a division of Lockheed Aircraft Co. (Continued on Page 14)

## INDUSTRY OBSERVER

**Amjet** General's XM-86 solid-propellant rocket motor, being developed under contract with Edwards AFB's 6799th Test Group (development), encompasses low-level power to increase specific impulse and control burning rate. Data from firing of one-third-scale uprated motor have indicated that total impulse of about 300,000 lb-sec. could be available in the full-scale motor. Full-scale motor could be top stage for USAF's first-stage Thor Scout booster and would use a glass-fiber case and measure 18 in. dia. by about 42 in. long.

**First fine-grained infrared measurements** of the earth and its atmosphere from a satellite, recently accomplished by Air Force Cambridge Research Laboratory associates using an Air Force Dornier satellite, are expected to provide bulk needed data to solve problems with the Moon early-warning satellite (AW Sept. 24, p. 54). Measurements were made over spectra of 1.8 to 16 microns using an ultra-sensitive radiometer-type spectrograph through six pounds and developed by Black Associates, Cambridge, Mass.

**Avco-General Corp.** and **United Technology Corp.**, each working under subcontract to Radio Corp. of America, will soon demonstrate the characteristics of 2,700-hz. three-channel active filter channel designs in the USAF Aerial Engineering Development Center facilities. Both channel designs feature glass-fiber wave environment. North American's Backdoor Division is pushing company-standard channel channel development in 7,500-hz. channel, also featuring external wave for reinforcement.

**Boeing Co.**, as expected to request proposals for special strap-on/rocket boosters for the 5-IC cluster of five Rockwell's F-4 liquid-propellant rocket engines comprising the first stage of NASA's Saturn C-3 booster. No motor now are available to fit the requirement. 5-IC is a part of the effort of Boeing and Marshall Space Flight Center (AW Aug. 31, p. 52), will measure 35 ft. dia. by 136 ft. long, have a dry weight of about 200,000 lb. and carry 4.4 million lb. of propellant. Boeing is scheduled to produce 24 5-IC units at Midland.

**Developments** in solid-fuel radar antenna design point to major reductions in overall length of the next round of systems. Current solid-fuel antennas on the Grumman M-100 are about 17 ft. long. At least one company is planning on a one-foot-long antenna for its next milestone.

**Air Force Office of Aerospace Research's** Program 35, administered by Space Systems Division of USAF Systems Command, is scheduled to launch the next Blue Scout from Ft. Appling, Ga., to test a payload into an elliptical polar orbit. Program 35 encompasses both day-space probe and orbital mission, encompasses either 100-lb. or 200-lb. payloads, which are scheduled to launch from only a relatively short time before first light.

**Aerospace** designs have been designed for the **Vought-Hiller** 30X-142 V-142 in service transport (AW Sept. 1, p. 24) to increase the flow around the wing and improve the lift and the release between the vertical lift and landing. Wing has not been shown some flow boundary, increasing the lift to increase the lift and increase the lift.

**National Aeronautics and Space Administration** will not accept **Marin Co.** and **General Dynamics/Aerospace** to submit results of their **North** boost-vehicle configuration and payload studies until April, although original target date was this month. **Boeing Co.**'s study, already submitted and under review by NASA's propulsion personnel, indicates performance for 200-lb. and larger solids, a heavy change in view of the decision by NASA and Dept. of Defense to proceed with feasibility demonstrations of large solid-propellant motors (AW Nov. 22, p. 35).

**Ryan Aeronautical Co.** has prepared a version of its **Flamco** drive, with aerospace performance, as a weapons system to deliver biological and chemical warheads.

# SILICOLOGY

REPORTING ON:

## An Application of Silicone Technology

### A gyro puts a missile on a pinpoint... and a silicone fluid smooths the way

The highly critical area of missile guidance provides an example of how Union Carbide Silicone Fluids can meet your most precise specifications. In the Hawk I ground-to-air missile, flight control is provided largely by the ion current rate gyroscopes strapped to the airframe. This location results in a built-in problem of unwanted vibration. And since the target can be as close as 100 feet from the target, the gyro must be able to operate at temperatures as high as 100°C. The problem is complicated by the range of temperatures through which the missile passes.

Since the guidance system must remain stable throughout, the gyro requires a minimal vibration damper. This Union Carbide's Silicone Fluid L-45, 1413-viscosity. A film of the fluid between the gyro's gimbals and external frame provides constant resistance at frequencies near the gyro's natural resonant frequency. In this way, the gyro's response characteristics are shaped as desired in the frequency range of interest without affecting static response. And since L-45 maintains its



Target for the Hawk I missile is a ship at sea or on land. Union Carbide Silicone Fluid L-45, 1413-viscosity, provides constant resistance at frequencies near the gyro's natural resonant frequency. In this way, the gyro's response characteristics are shaped as desired in the frequency range of interest without affecting static response. And since L-45 maintains its

#### THE KEY: PRECISE FORMULATION

The L-45 series of silicone fluids is available in a wide range of viscosities. Heat exchange devices, electrical systems, hydraulic systems, liquid springs, and other mechanisms are utilizing silicone fluids that are precisely engineered to the task. In their formulation and production, Union Carbide maintains a rigid quality control program to provide the uniform performance properties on which you can depend.

#### SEE YOUR SILICONES MAN

With its pioneering background in silicone technology, Union Carbide is constantly achieving new breakthroughs in these versatile materials. Your Union Carbide Silicones Man, supported by extensive resources of technical expertise, is an authority on his field. Get to touch with him to learn what is being done in silicone today. Or, for further information, send us the coupon below.

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#### FITTING YOUR NEEDS

This excellent viscosity-temperature characteristics of L-45 is a primary reason for its usefulness as a thermal resistance damper in these examples. For example, it provides these properties:

Coefficient of thermal expansion

$5.7 \times 10^{-6}$  cm/cm/°C

Viscosity-temperature Coefficient 0.02

( $-300^{\circ}\text{F}$  to  $+300^{\circ}\text{F}$ )

In addition, it has a flash point over 600°F and a pour point below -20°F. But this is only one application for silicone fluids, and Union Carbide is capable of supplying formulations that will meet any specifications set for any job, where these materials will work. Your Union Carbide man, the just as serious as those involved in missile guidance, if you'll do well to talk to Union Carbide.



Precise engineering of gyro's ion current rate gyroscopes for ground-to-air missiles is a time-consuming process that can be aided by Union Carbide's L-45.

## Washington Roundup

### Science News Confusion

Confusion over the release of scientific findings concerning the radiation belt created by a similar blast last July 9 continues. Dr. Jerome R. Wosner, who wrote last June including that of presidential science adviser, has "misconstrued" that National Aeronautics and Space Administration and no address said there is agreement on the interpretation of the data on the radiation belt.

Following the unprecedented bureaucratic procedure, NASA is interpreting the "misconstrued" as a note. But both Wosner's office and NASA deny that Wosner's efforts to slow down the quick dissemination of scientific findings that NASA has waited for last year to achieve. Some NASA scientists had anticipated Wosner's action as a general attitude against quick release of such data.

Some information on the radiation belt was first made public in a scientific journal by two of NASA's Goddard Space Flight Center scientists, some time after a closed meeting between NASA and Defense Dept. was held to discuss the belt.

Dr. James A. Van Allen, whose team's satellite first detected the belt and who has expressed about Explorer 34 and 35, which are exploring it, apparently agrees with Wosner that information should be rechecked before it is released. But he disputes that it is still too early to release findings from the two new Explorers. Although NASA has been precluded by its interpretation of Wosner's "misconstrued" from releasing any findings on the belt since Oct. 11, Van Allen revealed last week that the satellite and lifetime of the belt will be less than anticipated last August (see p. 24).

### B-70 Flight Delayed

First flight of the USAF-North American B-70 has been delayed from December until next March or April by testing fuel tanks. The testing problem is related to the changing temperatures that the Mach 3 bomber will experience. Results of studies by Air Force and by the Joint Chiefs of Staff on the B-70 and its B-57 reconnaissance strike version have not yet been discussed by the Defense Dept.

Progress of the British-French supersonic transport program (see p. 40) has prompted Federal Aviation Agency Administrator N. E. Hobbie to try to accelerate U.S. supersonic transport plans. Hobbie will present recommendations to President Kennedy within a few weeks. They will include cost estimates, basic research and development needs and a time schedule for the proposed program.

### TFX Decision Due

Long-postponed decision on who will build the F-105 fighter (TFX) is due to be announced this week. A last-minute fight occurred last week but Defense Secretary Robert McNamara's office and Air Force and Navy were expected to have the matter settled by Nov. 19. Boeing and a General Dynamics-Corona team are the finalists. In the meantime, underestimation of the cost, USAF Air Secretary Joseph S. Jasek said last week. "When the matter is decided upon, he and the government will know more about the task to be undertaken than at any previous point in the process of a complex new system."

Watch for Rep. John Moss, Democratic chairman of the House Government Information Committee, to express his views on the Kennedy Administration's handling of data during the Calicut event before the California Fair Area, in San Francisco on Nov. 10. Rep. Moss' committee, which has issued as the "watchdog committee" on consumer government since since late 1975, has been for the last several days with the executive branch that when Republicans were as the White House. But the subcommittee's report of the way Calicut news was controlled is expected to result in public hearings early next year (AW Nov. 12, p. 25).

### NASA Information Plan

Plan to make information officers integral parts of NASA's main program offices (AW Mar. 5, p. 17) has finally taken effect, in spite of fear in some quarters that it may produce less information than it will. Since these press officers now will be partly responsible to their technical chiefs. For instance, former deputy public information director, already has moved into the advanced research and nuclear propulsion program office. Paul P. Hasey, former news chief, has moved to succeed Allen J. French. French has been assigned to the international programs office for several months. Walter A. Friedman, former coordinator of astronautics for international trade fairs at the Commerce Dept., replaces Steve Brown. Brown will now have a relatively small news room staff to deal directly with the press and public.

France will have nuclear bombs with yields of 60 kilotons by 1984, according to the official French publication National Defense Review. Nuclear strike force really will consist of Dassault Mirage 3 bombers and Dassault Etendard 4 strike fighters.

—Washington Staff







Rearview of cruise coasts from two Russian sailboat wings before, under on deck of the Soviet ship Boldukh shows similarity of early entries to the latest version of the Skyler MRBM (below), photographed at the Nov 5 Boldukh parade in Moscow. Although down right anti-aircraft (missile) armament, slightly fixed deck is visible. With some crew, Skyler shows below entrance about 50 ft long. Work-out the 15 ft. nose cone, as on the ship, dimensions correspond closely with those in U.S. photo reconnaissance pictures of Cuban MRBM sites (AW Oct. 25, p. 34).

## U.S. Monitors Ships Returning Red MRBMs From Cuba



Path-covered missile on the Soviet ship Luchik, photographed on the same day as the Boldukh, Nov. 5, indicates a truncated delta for configuration, viewed of the delta shape on Skyler (below). Skyler's photographed at various Russian parades reveal differences in length, its shape, deck and fittings for external plumbing in electrical lines.



Arsen's framework in Cuban missile overflights is caught in an aerial photo of a Lockheed F4V Orion of First Squadron 41 and the Arsen's crew monitoring the progress of the Soviet ship Arsen (below). Arsen's (in another view below) is carrying eight missile transporters with unencased MRBMs. Note Arsen's exposed masthead, indicating lightweight nature of load, like that on the Soviet freighter Polaris photographed earlier carrying missiles in the English Channel (AW Nov. 12, p. 32). F4V was delivered in first open broad daylight late in the mission (AW Sept. 37, p. 81).



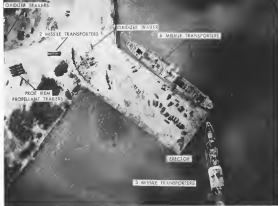
Soviet freighter Tikhonov (below), photographed Nov. 5, carries a unencased missile carrier as well as its unencased missile transporters.







Three Russian frigates, with keelies open, but VIKING and support equipment Nov 2 at the super Cuban naval base of Miami 18 mi west of Havana. Russian equipment designated, Defense Dept and some missile launch tags were present. The missile sets on three sets tags when carried to a remote position.



Loading of Soviet MRBNs, transporters, launchers, oxidizers, fuel and oxidizer tanks and other support equipment numbered by U.S. photo reconnaissance at the Cuban naval port of Miami showed progress made over a four-day period. Equipment was at dockside and loading at three ships was getting under way Nov. 2 (left, top). On Nov. 3 (above) the frigates Bratka (top left) the dock side, the Divingson, with three missile transporters and one oxidizer is being off the dock and six missile transporters are loaded on the deck. Two other missile transporters are on the dock, probably destined for the Ancon, which departed with right. Also visible are four propellant tanks and eight oxidizer tanks. Exhausted sections of the inner dock area (left, below) shows four large and 10 smaller fuel trailers and 11 oxidizer trailers besides the four missile transporters designated. Another area at Miami for some days (right) revealed 17 covered missile sections, and 16 launch stands, 12 of them loaded in the sections. The four unloading ones are designated: 018, covered 41 missiles on right; Soviet frigates as of last week. Besides the Ancon, the last was Lakshmi, two: Bratka, two: Krasnodar, right; Krasnodar, ex: Divingson, dock; Volgograd, seven; Falmouth, six.



# Saturn SA-3 Aimed at Further Testing Engine Cluster Concept

By George Alexander

**Case Casswell—Third flight of the Saturn C-1 launch vehicle, scheduled for late last week, was programmed to be a further test of the clustered engine concept that the previous two C-1 flights and, in addition, was to serve as a testbed for a number of C-1 Block-2 motions and procedures.**

Built by the National Aeronautics and Space Administration's George C. Marshall Space Flight Center, Huntsville, Ala., the third Saturn-designated SA-3 was a Block-2 vehicle like the SA-1, SA-2 and the yet-to-be SA-4 boosters.

Block-2 vehicles will be introduced into the flight test program with SA-5—now tentatively scheduled for August, 1965—and will be differentiated from Block-1 units by increased propellant capacity, greater thrust and the addition of stabilizing fins to the aftfins (AVR July 2, p. 11).

SA-3 was to be loaded with 710,000 lb. of liquid oxygen and hydrogen-like RP-1, an amount of 110,000 lb. over SA-1 and SA-2. Because of this greater propellant load, SA-3 was programmed to burn approximately 30 sec longer than its predecessors and consequently fly a higher and longer ballistic trajectory down the Atlantic Missile Range

this effort of the earlier vehicle. Maximum altitude of SA-3 was expected to be 101 mi., compared with 85 mi. for both the SA-2 and SA-1. Retro-pulsed range was expected to be 770 mi., compared with 525 mi. calculated for SA-2 and 215 mi. for SA-1. Velocity at burnout was to have been about 4,000 mph., or roughly 900 mph. faster than the preceding flights. SA-3 was successfully flown Oct. 27, 1961 and SA-2 Apr. 25, 1962.

Because of the greater weight it was to carry, SA-3 was to have accelerated more slowly than either SA-1 or SA-2 and, in so doing, place heavier demands on the flight control and propulsion systems than has been experienced to date.

Engineering model of the ST-124 stabilized platform, a major element of the C-1 Block-2 inertial guidance package (AVR July 3, p. 11), was to be flown open-loop and its performance measured.

Other Block-2 items tested by SA-3 included four solid propellant rocket motors programmed to fire for 12 sec. after shutdown of the first inboard engines but which were not to effect stage separation, and one panel substituted for a regular Block-1 inert in the test should just above the engine compartment.

Cutoff of the engines was to be triggered by a propellant utilization system, unlike the timer used on the SA-1 and SA-2 flights. Level switches were to shut down the first inboard engines after approximately 95% of the propellant had been consumed and the four outboard engines were to continue burning until the liquid oxygen was depleted. Approximate burning times of 140 sec. for the outboards and 147 sec. for the outboards were expected.

Two dynamic pressure transducers were mounted on the aftfin section between the dozen payload and third stage. Eleven points on these two panels were to measure the pressure applied to the devices and the rate of onset, data is expected to be used in the analysis of the first Centaur's failure. It is thought that a structural collapse in first stage segment caused the explosion of the Centaur last May 8.

On the ground at Complex 14, from which SA-3 was to be launched, a newly installed 240 ft. auxiliary mast was to be used in a test for fireproofing Block-2 vehicles. Not required for the first four C-1 flights, where only the booster is lost, the mast will carry power instrumentation and air-raid warning to the last second stage and payload for Saturn SA-5 and succeeding vehicles.

SA-3, which was expected to develop about 3.5 million lb. thrust on its eight Rocketdyne H-1 engines, was accompanied with 716 telemetry channels. Of these, 612 were in flight channels, reporting data on such parameters as engine turbine temperature and rpm, temperature in engine head, heat exchanger outlets, oil sump and turbine oil levels, pressure in combustion chamber, propellant tanks, dummy upper stages, various dynamic forces exerted on the vehicle, performance of the ST-124 platform, engine pre-burning, propellant tanks correlated with engine cut-offs, battery voltages and current and converter frequencies.

SA-3 also carried, for the first time in the C-1 flight test program, a pulse-code-modulated (PCM) transmitter in the S-1 stage and an ultra-high-frequency (UHF) transmitter in the payload.

Regarding the experiment first conducted with SA-2, the vehicle was to have been deliberately destroyed after burnout of the S-1 booster so that the 95 tons of water ballast in the dummy second and third stages would be ejected into the upper atmosphere.

Experiment, called Project Highwater, is designed to study erosion characteristics of the congregate through the effects of that erosion as the ice cloud formed by the water. Destruction would be caused at the apex of the structure, at about 184 mi. or 185 sec. after lift-off.



**Engines Installed on Saturn SA-3**

Six of the eight engines that will power the 3.5 million lb. thrust Saturn SA-3 are in place at National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, Ala. SA-3 is the first of the Saturn Block-2 vehicles. It will be the first Saturn with full fire and designed package for more propellant and will carry a live second stage.

To give a boost to booster rocket production, specialists at Lukens "apex" heads in the widest range of sizes, shapes and materials available—anywhere. Important uses for these versatile metal domes range from rocket and closures to missile nose cones. . . from cryogenic storage tanks to huge industrial boilers. Lukens heads are produced in diameters up to 21½ feet, in thicknesses up to 7½ inches. Technical assistance on materials selection and design is always available. Write or phone collect: Manager, Application Engineering, Lukens Steel Company, Coatsville, Pennsylvania, Telephone: DUelley 4 6200.

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A QUESTION OF SUPREMACY:

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To simplify the satellite acquisition process, NASA is sponsoring the development of a more advanced automatic tracking system called the Tracking and Data Relay Satellite System (TDRSS) by Hughes Aircraft Corp. This new tracking automatic (digital) optical tracker (RADOT) will employ a digital computer and a magnetic tape drive to store and process satellite-related parameters obtained from NASA tracking stations.

Finland government hasn't disclosed how many Soviet fighters have been brought down by its fighters, but about 20 MiG-21s are involved.

Company also predicted its total revenue for 1962 will be about \$184 million, a drop from last year's figure of \$149.4 million. Work force, as of September, has been reduced from 51,945 a year ago to 41,320 employees.





## Reactions To UAL One-Class Trial

New York—United Air Lines' competitors on the Chicago-Los Angeles and Chicago-San Francisco routes have mixed reactions to UAL's Fawcett W. A. Fawcett was a plan to begin experimental one-class service on one of their routes by May 1, 1984, at Civil Aeronautics Board approval (p. 32).

Partners objected to an on-ice service plan (AWB Oct. 15, p. 30) according to San Francisco. He said he would like the experimental law with CAB in Boston but to begin by May 1.

Four Boeing 720 jetliners would be converted to 2-3 seating configurations with 100-passenger capacity plus the longer Parton and a new seat and drink would be included in the service.

Partners predicted the law license would not exceed 450, which takes with the recent 150 federal transportation tax cut, would have another line at about the present coach load.

Tom Waddell, United President Charles C. Ellington Jr., opposed the market law, saying it would "reduce the market impact to first-class passengers and cause a significant increase in fares now enjoyed by each passenger."

"The American consumer is used to making his own law choice—whether it involves automobiles, refrigerators or clothes—no significant industry has to use knowledge gained to force the consumer to accept a single pre-determined grade of product or service," Takahashi added.

Continental Air Lines said it must evaluate its own business-line experiment (AWB Aug. 20, p. 47), which it characterized as "uncoordinated, but too early to tell" before it could comment on United's one-class plan. Continental planned to file its own statement of its experimental law to Feb. 15 to obtain approval from both domestic operations during the Christmas season.

American Airlines' United flight competitors on the Chicago-Los Angeles and Chicago-San Francisco routes said its management still lacks data on how the law-class service in the airline market, but that it was studying Parton's proposal.

United spokesman indicated that testing on that carrier's Boeing 720 jet fleet was on order, has been added to a schedule, 50 test configurations—three fewer than under the original coach, business configurations. The new seating is the same type United would use on its one-class 720.

switch of passengers from first-class to coach travel.

All but Northeast reported gains in coach travel in October. Industry in transit during the month in coach traffic rose 19% over the same period last year. California led with 52.1%, a 4% drop from October of last year, due to a 27% increase in coach available seat miles.

San Diego showed spectacular improvement in the volume of coach traffic handled during October. Delta reported an 89% increase. Continental 59%, Northwest 95%, National 58%, Braniff 34% and Western 34%.

The 4.4% increase in total revenue passenger miles for the 10 airlines does not reflect the traffic activities of individual carriers any more than the industry's total profit figure ignores airline individual carrier gains.

Beth Barney and Northeast, for example, showed declines in revenue passenger miles. American, TWA, United and Delta reported slight traffic increases, but National's total traffic declined 2.5% and Delta 2.2%.

It can be presumed that these two carriers are benefiting from the recent cutbacks in their routes to the West Coast. Continental, Northwest and Western reported substantial gains in total revenue passenger miles.

During October, United held its posi-

tion as the airline's leading carrier in terms of traffic handled with a total of 641.5 million revenue passenger miles for the month. American generated 544.7 million revenue passenger miles for the period, and TWA was third with 382 million.

Local service airlines continued to show strength during October with a 17% increase in revenue passenger miles and a load factor of 41.3%, only slightly lower than the 42.4% reported in October of last year. Only two local service airlines failed to show a gain in revenue passenger miles during the month.

## Inquiry Could Affect 100 Regional Airports

Washington—Scheduled airline service on only 500 airports nationwide may be affected by the Civil Aeronautics Board's current series of regional airport investigations.

The investigations are designed to reduce the airline's liability loads by considering closing airports with low passenger loads to two or more cities. In four separate actions, CAB is considering service cuts in 19 cities in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Delaware, Wisconsin and Texas.

It is probable that CAB will expand the scope of the investigation to 30

include other areas of heavy consolidation throughout the country. The Board estimates that 18% of the 145 certified airports currently compete with each other. This competition is increasing in even steeper, the Board contends and stands at 36% in Hawaii, 32% in Michigan, 33% in New York, 20% in Texas and 31% in Oregon.

The Federal Aviation Agency, in supporting the Board's regional airport program, has said it will not provide and funds for airports being investigated by CAB. FAA noted that in several past cases it has required for less federal money to build a new airport serving this or more communities than it did to maintain two separate airports in a nearby area.

Without doubt, scheduled service from one airport has usually resulted in its use as a much needed general aviation airport, reducing air traffic and requiring less federal support for such items as runway lengthening and tower additions necessary for most scheduled airports.

Industry observers believe CAB's program may face less opposition than expected from those communities, primarily because of the increased value of land around major airports, which could make it difficult for communities to withdraw from the facility with a profit and participate with FAA aid in the construction of a new airport to be shared with a neighboring city. At the same time, they concede that construction of service on such areas as Dulles and Ft. Worth, which is a separate CAB regional airport investigation program, may be accomplished only by a new Board rule.

The Board's regional investigations were spurred by three circumstances: Northeast Airlines' financial problems, aggravated by the month of providing scheduled service in actual insolvency; New England Airlines' and reorganization; and a group of New England state airline officials that scheduled service at 15 airports be abandoned and operations consolidated into 25 other regional airports.

Generally, the CAB investigations concern cities which are located within a 50-mile radius of each other. Many areas around transportation hubs have been cut or reduced to be limited to 10. Other considerations, such as present and future road conditions and transportation facilities, would enter into the selection of a regional airport.

CAB noted that many communities are considering closing airports with low passenger loads to two or more cities. In four separate actions, CAB is considering service cuts in 19 cities in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Delaware, Wisconsin and Texas. It is probable that CAB will expand the scope of the investigation to 30

highly view of Dulles terminal was taken from north entry used by airport visitors. Public parking area for 5,100 cars occupies space to the immediate back of building. Airline trailers will disperse from mobile bays at main terminal level, downed to a lower level by escalators for baggage pickup and departure transportation. Dulles International Airport became operational Nov. 19.

## First Scheduled Service at Dulles Begins

By Robert H. Cook

Washington—Dulles International Airport became officially operational Nov. 19 with 58 flights scheduled to be handled. President John F. Kennedy and Vice President Dwight D. Eisenhower were to attend dedication ceremonies Nov. 17.

Eastern, Trans World, Delta, Braniff and Northwest Airlines are providing the first service into the 510 million federal facility with 13 hangar and 23 private engine flights. Eastern's 36 flights account for more than half of the total. TWA has the next highest frequency with 12 flights.

American Airlines will inaugurate Dulles service on Dec. 3 followed by Pan American World Airways on Jan. 6, and United Air Lines on Jan. 15. National, British Overseas Airways Corp., Northeast, Allegheny, Lake Central and Piedmont Airlines are expected to commence Dulles schedules in the near future.

Although officially operational, Dulles is still being constructed. Delays and probably will not be completed until March of next year, FAA sources indicate (AWB Aug. 30, p. 36).

Most of these remaining problems are considered minor and primarily related to the completion of installation of new automated and automatic areas within the terminal building, such as baggage claim conveyors and main entrance doors. Work is still in process behind heavily-arched partitions on main aisleway ticket counters, concourse stands and jet apron operational buildings.

Under the terms of its construction contracts, FAA has demanded liquidated damages ranging from \$500 to \$5,000 per day from contractors for each day's delay in meeting completion dates. At

this time, these FAA damage claims could total \$450,000, over the finaling contract on the terminal building alone called for a completion date of July 19, with assessment of liquidated damages at the rate of \$1,000 per day.

However, it is doubtful that FAA will fully implement the assessment clause, since some time extension have been granted, and because these assessed would probably take the matter to court. They would mean that much of the delay has been unavoidable due to weather conditions and plan changes made by the FAA, agency sources said.

While FAA states its dedication target date of Oct. 1, a considerable number of additional contractors and subcontractors were available to permit on-site landings and takeoffs by that date. Since then more than 4,000 practice operations have been conducted at Dulles runway.

Beth Barney's north-bound oriented aircraft carriers are equipped with two-engine engine lighting, centerline lighting and reverse glow lights. A third (3,000-ft) east end runway is equipped with a Visual Approach Slope Indicator (VASI) to aid pilots in maintaining a proper glide path while landing under limited visibility conditions. The VASI system will later be added to the north-bound runway.

Eleven mobile hangars, which eliminate the need for terminal "finger," are in operation at Dulles, and the balance of an aisle at 30 is expected by March. Design of the terminal building currently provides 23 lounge decks. This may be expanded to 36 when traffic growth is expected to require a doubling of the buildings passenger 608 ft length, according to FAA Administrator N. F. Hildebrand.

Hildebrand noted that long walks have

already been eliminated at Dulles, through use of the mobile hangars, "by means that airports should not be 'eye' sources or tuckers' requiring long and increase miles between the ticket counter and boarding gate."

Hildebrand concluded that Dulles is still not fully finished, but said he can tolerate it is important to have it operational "as a business airport" as soon as possible.

The taxpayer was told it would take \$60 million to build this airport two years ago. We looked at it, found the cost underestimated and set a new figure of \$106 million with a new contract of the full New York's made it," he said.

Public demand for service will be the deciding factor in the airline's decision of service at Dulles and the volume to be situated at Friendship International Airport, in Baltimore, Md., he said.

By 1975 traffic growth in the Washington-Baltimore area will require the use of all three area airports—Dulles, Friendship and Washington National—as well as those now general aviation fields, the FAA administrator predicted.

FAA has a large investment in Friendship, considered it a good, safe airport and wants it to be "there," Hildebrand said.

However, he said, Dulles' location closer to the traffic population center of the area, as created by FAA studies, may create a demand for more Dulles schedules. It might be "10 to 15 years, maybe as little as five" before Friendship could succeed in absorbing some of its traffic traffic, he said.

"The one thing I want to emphasize is that we're going to need all three airports over the long term," he said.

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CARGO LOADER DEVELOPED for USAF 46L is demonstrated on wood mockup of Lockheed's C-141 at Minot, Ga.

## Air Cargo Standardization Program Urged

By James R. Ashlock

Atlanta—Airlines seeking to standardize their cargo operations cooperatively in the interest of better service for shippers are adopting as guidelines the Air Force's 46L system and techniques compatible with trucking fleets.

The 46L, Military Handling Support System (AW June 11, p. 54) is a strong influence since it is a study in simplicity of standardization in the various areas of cargo aircraft design, performance and ground handling techniques. However, 46L delegates to the International Force on Air Cargo how aircraft were constructed against adopting 46L standards strictly in the interest of streamlining war and/or cargo loss.

Reg. Gen. James G. Sherrill, commander of 304th Air Transport Wing of MATS, and the Lockheed C-119B and C-141 transports will enable MATS to carry much of the volume now committed to commercial carriers. In the final run just ended, the aircraft loaded 518,000,000 in passengers, cargo and mail, or about 50% of the military transportation traffic.

"While we can expect demands for military airlift to continue on the upswing, I think we must also recognize some part of the slack between

demand and supply will be taken up by MATS increasing capability," Gen. Sherrill said.

"For this reason, although we will all agree need the capable backup of the commercial airlines in our logistical operations, it is apparent to overcome that the growth of the commercial air cargo industry should not and cannot depend entirely upon military requirements," he added.

Airline officials attending the forum, which was sponsored jointly by the Institute of Aerospace Sciences and the Society of Aerospace Engineers, said 46L was an acceptable standardization pattern because it has features for transfer of shipments between air and surface vehicles.

The set-in-place cross track will continue to be the umbilical cord of our air freight operations," said Henry F. Johnson, president of Air Cargo, Inc.

"We must adapt our system to work with trucks, rather than have trucks change to suit our needs."

The 46L cargo pallet measures 55 x 100 in., and agreement was given that the 55-in. dimension should be adopted as standard, since it conforms to truck-bed width.

Several trucking representatives questioned the 55-in. width, citing that only

55% of the trucks in the U.S. and fewer in Europe are wide enough to take it. Others said narrow trucks are mostly older models rapidly being replaced by vehicles with 60-in. widths.

An airline cargo official reflected that "if we could get 50% of the trucks in this country to work supporting air cargo, we'd be rolling in profits."

William L. Peterson, vice president of equipment research for American Airlines, said standardization was already partially under way among air cargo carriers. Boeing 730C freighters ordered by American and Pan American World Airways and Canadian CL-44s are the all-cargo operations have sufficient structural compatibility with 46L. Standardization among loading systems will also result as carriers purchase mechanized pallets most efficient through experience, he added.

The 55-in. pallet is uniform, in most cases at present. Besides the 55 x 100-in. 46L pallet, there is one measuring 55 x 108 in. for the CL-44. On the 730C, Americans will use not only the 46L pallet, but also others measuring 55 x 68 in. and 55 x 125 in. (AW Oct. 29, p. 43).

Still to be resolved are variations in aircraft size, terminal facilities, ground handling equipment and the legal use of materials and type for international

# MISSIONS & MILESTONES

BOEING-VERTOL  
TANDEM ROTOR "FAMILY"

## MODEL XH9PK



1948: Developed for the U.S. Navy, the XH9PK, world's first successful tandem rotor helicopter makes first flight on March 6.

## MODEL HUP



1950: The Boeing-Vertol HUP plays a specially useful role in the sea operations following the space flight of Lt. Colonel John Glenn. In the accompanying photograph the helicopter is lifting the astronaut from the Deshauss U.S.S. Not to take him to the U.S.S. Ram (left). 1955: HUP is first helicopter to be flown with an automatic pilot.

## MODEL H-21



1952: Boeing-Vertol H-21 assault helicopters are assigned to high altitude by the U.S. Army to combat paratrooper operations in South Viet Nam. 1958: The French Army puts H-21s into service in the Algerian conflict. (The more than one hundred introduced this design have produced invaluable operational data used in developing improvements and refinements in later helicopter models.)

## MODEL 107



1955: Passenger aircraft configuration of the 107 is copyrighted by the FAA... delivered to New York Airways. 1959: Military version of the 107 wins U.S. Navy competition for a marine transport helicopter.

## MODEL HC-119 CHINOOK



1955: The HC-119 Chinook, America's most powerful helicopter, is in large scale production and flying. It spins speeds over 300 mph with higher than normal rotor speeds. 1957: First Chinook completed and ready for ground tests. 1958: Vertol Chinook gets go-ahead to develop a new 25-ton capacity transport helicopter for the Army.

VERTOL  
BOEING



SPRING LOADED ROLL REARING rolls in the Douglas DC-8F facilitate easy movement of pellets. Mechanism is compatible with the existing A6C system.

shoppers. "Standardization will result," Littlewood said, citing a commercial source for it among cargo agencies. "But it will take a lot of agreement, and some heads will be knocked together."

Littlewood said carriers want cooperative work in deciding what type of aircraft best meets a program of standardization, then have the manufacturers build it. He said the only reason the Douglas DC-8F and Boeing 738C have identical floor widths is because the airlines jointly determined the dimensions when the passenger version of these planes were being designed.

"The next generation of cargo aircraft should be designed toward standardization," Littlewood said.

Example of the need for uniformity among aircraft, Littlewood said, is the C-141's inability to take pellets loaded as high as those that can be placed in the 738C or DC-8F. The Lockheed L-100, commercial version of the C-141 (AW Oct. 29, p. 41), will be able to take larger containers, because of its red loading feature, than those that run up into the side doors of the Douglas and Boeing freighters.

Consenters discussing program standardization at the meeting here determined that several agencies the military, the FAA, and the Navy, have been taken toward standardization and processing of cargo for shipment. It also means, in paperwork, uncertainty is practically nil.

"The meeting should have been held two years ago," said R. F. Shaw, chief marketing development engineer for Lockheed-Georgia Co., and general chairman of the forum. "But concern over standardization wasn't acute in comparison to the air it is today."

Shaw said it is doubtful whether any appreciable standardization in air cargo operations, and in standard cooperation, will result before 1970. To get it even that early, work must begin

now, he said (see following story).

"If we don't attain standardization, if the airlines fail to agree, then we will not achieve as far along as the freight market," Shaw said.

He stressed time as the main problem. With air cargo volumes growing, carriers must buy the airplanes and support systems and adopt the practices that meet their immediate needs. The airlines that go the farthest may be the most reluctant to change to any standards proposed later, he said.

"To obtain a greater share of the market, we must standardize," Shaw said. "Today, the airlines are carrying only 4% of 1% of the world's freight volume."

"I think we'll ever get more than 10%," he added. "But if we do gain 1% of the market, we'll square back as many carriers as we need to get the program started."

Alan S. Bond, chairman of the Civil Aeronautics Board, endorsed the effort's efforts in a speech to the forum delegates.

"Cargo is not a stepchild in our philosophy and action," Bond said.

"We are working to develop less burdensome staff filing procedures. We are exploring the great possibilities of great airframe movements, trying to bridge the regulatory gap between the Board and the Interstate Commerce Commission."

Bond said the CAB is also trying to develop a suggested rate philosophy for cargo, one that is grand toward a fair return for the service.

"Let me emphasize that we are not seeking to force any carrier into any particular rate-making philosophy," he said. "We are trying to find a strong point in the hope that everyone will reach agreement on when the race is to begin."

Next move in the cargo standardization program is a February meeting in

New York coordinated by the Society of Automotive Engineers. Standard and uniform regulations will be issued as well as officials of U.S. and international standards bodies.

"We also want this to be the first of the International Air Transport Assn. to include a program for standards among IATA members."

## Slick, Surface Movers Discuss Cargo Service

Dallas, Tex.—Slick Airways held its first meeting here last week with executives of six major surface freight carriers to discuss details of a new truck-trailer, cargo service based on crewless trailers now before the Civil Aeronautics Board (AW Oct. 1, p. 32).

Cooperative airfreight-truck program would provide joint service between between 1,180 to 2,000 points in California, Oklahoma, Texas, Indiana, Ohio, New York, New Jersey, Connecticut, Arkansas and Louisiana. Guaranteed service would feature a single wheel, axle, suspension and a "mechanical" loading system.

Rates of \$5.75 per hundred-weight between Galveston, Tex., and New York City, and \$15.75 per hundred-weight between Sacramento, Calif., and Bridgeport, Conn., are examples of the proposed rates.

Joint program calls for guaranteed trucking delivery for interstate aerial shipments. Service from Dallas to Los Angeles, for example, would involve a truck-trailer, 50th Cap. President and Board Chairman Dale W. Arnold said.

Bond said the meeting with key executives of the six carriers was to consider discussion of how the cooperative venture would develop joint sales and promotion efforts in the geographical area they serve.

He added that Slick plans to put much of its sales effort and money in the future into a coordinated program with its member surface carriers. Slick is seeking coordination of surface and air transportation, readily with trucking and centrally with Slick, in a cooperative enterprise, he said.

Under the plan, committees will be set up to develop early billing, coordinated promotion efforts and through-line schedules. A committee also will study development of a standard negotiable surface and air container system. Six surface carrier meetings with Slick are California Carriage Co., of Los Angeles, Commercial Motor Freight, of Indianapolis, Ind.; Le Wire Motor Freight, of St. Louis, Mo.; Pacific Motor Trucking Co., of San Francisco, Calif.; Polaris Trucking Co., of New York City; and Southwestern Transportation Co., Dallas.





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**WESTERN AIRLINES**



**FINNAIR MARK 3 CARAVELLE** is seen at Helsinki Airport. Note all motion Caravelle is visible at the extreme right. Finnair has four Mark 3 Caravelles.

## Finnair May Trade in Caravelle 3s To Finance Horizon 10B Purchase

Helsinki—Finnair-Northern OY, the Finnish national airline, may finance the purchase of an Caravelle Horizon 10B powered by Pratt & Whitney JT8D-1 turbofan engine in trading in its fleet of four Mark 3 Caravelles.

Supposed last week's work, the first sale by Sui Aviation of its Caravelle Horizon 10B. Even more important, the Sui-Finnair contract would be a precedent-making example of new jet aircraft being financed in part by trading in used jet transporters.

Aviation sources here say, Finnair would take delivery on its last Caravelle Horizon in March. Delivery of the first four aircraft reportedly would be spaced at three-month intervals so that Finnair could operate three Caravelle Horizons in the 1964 season. Delivery, at the last aircraft, might not take place until 1966.

Contracted with the Sui-Finnair talks in the possibility that the new jet, private Finnish airline during flight between in Western Europe in well as operating a domestic service in Finland now, come into the deal by trading a single Caravelle Horizon 10B. Thus, the first Finnish order would be some six years.

Finnair also has been studying the British BAC 111 transport, and the smaller twin jet may represent an alternative equipment plan for the airline.

The agreement involving payment in used jets, is far from set to negotiate, and preliminary indications could quash the report. The French airline, for example, initially indicated interest in taking over the Finnair Mark 3 Caravelle, or some of them, but then backed off.

Main reason for Finnair's attempt to negotiate a trade-in is lack of capital to finance the entire cost of the new equipment. The Caravelle Horizon 10B costs \$5.6 million, compared with

an initial price of about \$3 million for the Mark 3 Caravelle.

Then too, Finnair obviously would have to concern itself with disposing of its used Caravelles once it bought new ones. Purpose of the present agreement is to have Sui take over the responsibility of finding buyers for Finnair's used Caravelles. Trade-in price is believed close to the original price paid by Finnair.

For its part, Finnair has agreed to makeable its Caravelle major overhaul division, in order to permit latest modifications to be made. In this way, the used Caravelles will be up to date, at far as modifications are concerned, when Sui Aviation takes them back.

Finnair's present fleet consists of four Caravelles, all Mark 3, seven Caravelle 3s, and six Douglas DC-7s (AWN No. 21, 1948-9-9). Delivery of Finnair's last Caravelle took place last February.

Finnair's main international route still consists of a daily Caravelle flight from Helsinki to Paris via Hamburg and Amsterdam. The carrier also operates Caravelles from Helsinki to London via Göteborg, Sweden, four times weekly, and twice weekly Caravelle service between Helsinki and Moscow.

Members of Caravelle and Horizon used in servicing Copenhagen, Stockholm and Frankfurt. In winter months, when traffic declines to Moscow, the carrier often replaces the Caravelle flight with a Comet 440.

Reported purchase of the new Caravelle probably means Finnair after several years of weak stability, is planning additional European service. It is reported that Finnair will try to extend its routes toward such ports as Rome, Madrid or Barcelona. New equipment also could mean increased Finnair interest in charter activity, both on its

own operations and in renting out to other carriers.

At present, for example, Finnair charters a Caravelle daily to Lufthansa. After a Finnair Caravelle arrives at Paris from Helsinki on its daily run, it makes a non-stop flight to Frankfurt for Lufthansa. Finnair flight crews fly the charter, although the cabin crew is from Lufthansa. Once returned to Paris, the Finnair Caravelle then makes its return Finnair flight to Helsinki.

The arrangement has helped to push Finnair's Caravelle utilization rate to about 7 1/2 daily. The carrier's four Caravelles handle about 75% of Finnair's international traffic.

Finnair, although 1958 government-owned, operates with most of a profit and then provides government. The carrier receives no subsidy from the Finnish government. Finnair's basic operating philosophy, as explained by carrier officials, is that the airline exists to meet the traffic needs of Finland.

Sense of independence has almost led Finnair officials to turn down invitations to enter into the Scandinavian Airline System (SAS) consortium. Finnair, however, cooperates with SAS in a pooling arrangement on flights between Helsinki and Scandinavia points. SAS also does major overhauls of Rolls Royce engines used on Finnair Caravelles.

## New Argosy Version

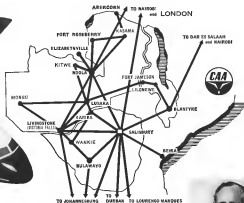
London—Westworth Gloster Aircraft, holders of the Rolls-Royce Dart-powered Argosy 400 transport, is negotiating with several U.S. airlines for a small passenger-cargo version loaded: 60 passengers and 14,000 lb. of freight.

Ray E. Lofgren, general sales manager, said recent design studies have been worked out for a short operating out of 4.5 miles on suitable runways for cargo, and 2.7 miles on suitable runways for passengers. Company toward the latest configuration design when it learned that Eastern Air Lines was considering replacing its Douglas DC-7s with smaller jets, and Alitalia Airlines and Alaska Airlines were exploring a smaller plane involving Caravelle 440s.

Westworth Gloster Argosy version, the 280 series which includes the basic wing for full full-scale operation, has been a full cabin-width loading door at the front of the cabin to permit straight-in loading of cargo up to 6 ft. 4 in. wide, 8 ft. 6 in. high and 20 ft. 1 in. long. Passenger door at the rear, and compartment is completely opened by a variable ballast to allow loading flexibility.

Series 280 Argosy now is in production for Royal Air Force Transport Command. Unless RAF desires to order more than 10,000 additional production will phase out by next summer.

# CENTRAL AFRICAN AIRWAYS chooses **BAC ONE-ELEVEN**



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**Mr. M. Stuart-Howe,**

Chief Executive and General Manager, Central African Airways Corp.

C.A.A.'s selection of the BAC One-Eleven for its short-haul medium-haul intercity services and for its routes between the territories of Central, East and South Africa has been made only after the most searching analysis—technical and economic—of today's aircraft for the service task of operating in comparatively high altitudes and high temperatures and into airports not all designed to take the largest jet aircraft.

C.A.A.'s need was also for an airplane which would provide a standard of passenger service—in speed, comfort, reliability and ease to flight—of ground handling which would enable C.A.A. to hold its own with long-haul jet operators over the Corporation's regional routes. Even now it seems that the BAC One-Eleven C.A.A. will have a pre-eminence that the public, pilots, ground staff and financial contributors will like.



## AIRLINE OBSERVER

► Pressure against the recent proposal by United Air Lines' President W. A. Patterson for a one-class transoceanic service (AW Oct 15 p. 45) are another sign that the domestic transoceanic industry is still a long distance from finding a primary formula that will be acceptable to all airlines. Wide-spread differences on rates and fares within the industry has focused the reluctant acceptance on more provisional forms and caused others to be dropped. This single-class fare proposal undoubtedly will stir a flurry of counter proposals, none of which is expected to win unanimous industry support.

► Next big order for the BAC 111 twinjet transport may come from American Airlines. American has drawn up specifications for the service it wants. If the order is placed, it will call for as many as 25 aircraft. Meanwhile, several local service carriers are showing active interest in the airplane. BAC's Airways is expected to receive to 75 its present order for ten, plus an option for ten.

► Russia and Sudan have formally signed a bilateral air transport agreement giving American rights to the Moscow-Riad route with four flights per week (3/35). Sudan is the sixth African nation with which Russia has signed an air transport pact. Aeroflot says the Moscow-Riad route can increase the Soviet carrier's total international route network to over 62,100 mi.

► Trans World Airlines negotiates plans, told by the carrier's Executive Vice President, to "assume" that funds will be available, are preparing a new evaluation of TWA's turbine freighter requirements. Canada CL-44 is included in the study package, but airline officials have put price to remain competitive with Boeing 700C turboprop all-cargo transports ordered by Pan American World Airways and American Airlines.

► First de Havilland Trident is being modified to lessen the final take gear to present landing gear stress due to landing forces on the air. A lever is being added to the suspension system to reduce capacity, and will be included in all future production models. In addition, de Havilland has decreased that the second wing fair, installed on the Trident as a precautionary measure, is not needed. It will be removed, resulting in a reduction in drag.

► Lockheed Aircraft Corp., accelerating its effort to break back into the commercial field, is moving research and development toward a supersonic transport and a practical VTOL aircraft, the two types of aircraft Lockheed feels will be the primary needs of the airline industry.

► Discussion has arisen in Military Air Transport Service circles about need for a large turboprop transport in the Douglas C-119 class. Since supersonic transport is against bidding on the project if it develops, since the order probably would be for a small number and such a special reason aircraft would have no commercial application.

► Feasibility of developing a bilateral air transport agreement with Red China is still being studied by Japanese government. Japan's foreign minister recently stated that the time is not yet ripe for a conclusion of an agreement covering air service between Tokyo and Peking. It is known, however, that a number of Japanese airline officials are anxious to begin such a service, but are deterred primarily by a government fear of increasing U.S.-Japan relations. Possible loopholes in Japanese attitude toward expanding trade with Red China, provided trade progress will be justified on grounds that economics and politics are separable.

► Financial problems and political differences on cargo equipment needs have stalled British Overseas Airways Corp. plans to order CL-44 freighters. BOAC officials have the order "dormant," not dead. Sources within BOAC say the delay may result eventually in an order for pure jets. BOAC has spoken to Vietnam about air-freighter potential of the VC 10. Luftansa also is reexamining its interest in the CL-44 (AW July 23 p. 34).

## SHORTLINES

► **Alaska Airlines** has expanded its all-range service from New York and Boston to Sacramento, Alaska, Tientsin and Rangoon through Seattle using twin-engine Douglas DC-7P all-cargo transports.

► **American Airlines** has reorganized a Ford Transcon aircraft operated by a professional company three decades ago and contributed it to the Smithsonian Institution's Air Museum in Washington, D. C.

► **British Overseas Airways Corp.** has incorporated a third route freighter service between New York and London using a Douglas DC-7 transport.

► **Civil Aeronautics Board** has postponed procedural steps in the U. S. Combinations American Route Case in compliance to requests by a number of participating airlines.

► **International Air Transport Assn.** technical committee will meet in Bangkok Nov. 27-30 in a regular session, but attention will be focused on navigation, communication and operational problems in the Bangkok area which, in recent years, has become a major hub of airline services in the southeast Asia sector.

► **Northeast Airlines**, in a flat challenge to Eastern Air Lines' Air-Shuttle, has asked CAB to approve a concentration tariff between New York, Washington and Boston at five cents per mile. Rates would be \$10 between Boston and New York and \$12 between New York and Washington, compared with Eastern's rates of \$14 and \$16 respectively. The rate would apply to tickets sold on a standby basis.

► **Quintus Engine Airways** has reported a profit of \$920,035 for the year ended May 31, a slight increase over the net profit earned in the same period last year. Continuing profit was attributed by the carrier to reduced costs, which were said to be among the lowest in the industry.

► **Swissair** has begun its winter transatlantic schedule with eight weekly round trips out of New York and two weekly round trips out of Chicago and Montreal.

► **Trans World Airlines** has reported a 9.5% increase in revenue passenger miles in October compared with the same period last year. Cargo ton miles increased 24.4% in the same period.

## Simplified Power for V/STOL Aircraft

Bristol Siddeley 140 thrust turbofans are the simplest power units for all V/STOL applications, because the total thrust can be used for both lift and forward propulsion. They permit the simplicity of a single engine installation on land with supersonic jet engines, ship provide a simpler and more economical solution than can be achieved with any replacement of separate lifting and propulsion engines.

### SINGLE-ENGINE INSTALLATION

- Simplified installation.
- Simplified aircraft structure.
- The smallest thrust and weight fig.

passes through a fixed point and is available for all other uses.

- Maximum and spare requirements are confined to one engine.
- Availability of a large power reserve for acceleration and deceleration.

### MULTI-ENGINE INSTALLATION

► Simple operation. Jet engines required as the total power source is also available.

### DEFINING FLIGHT

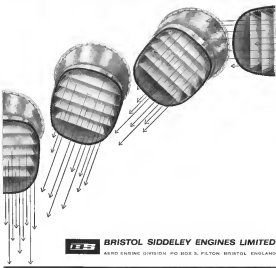
► Bristol Siddeley 140 thrust turbofans can be used in the low power during or power climb to give a thrust boost for

take off and emergency flight. This gives the aircraft a power reserve.

- A large thrust boost for emergency speeds with only a modest increase in specific fuel consumption.
- Engine performance matched to aircraft engine requirements.
- Can be used for transient acceleration.
- Greater engine efficiency.

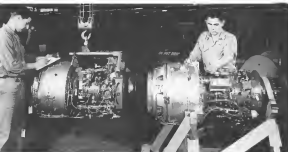
These Bristol Siddeley advantages are achieved more economically by powerplants than those by other engine types.

The development of Bristol Siddeley 140 thrust engine is supported by the US Government through the Mutual Weapons Development Programme.



**BRISTOL SIDDELEY ENGINES LIMITED**

AERO ENGINE DIVISION PO BOX 3, Filton, Bristol, England



MAJOR LYCOMING PRODUCTION LINE is a series of T55 and T55 gas turbine engines, typified by the T55-L-5 (left) and T55-L-4 (right). First of the T55 series to enter service, the L-5 is used at 503 military ship. T55 series entered service at 2190 military ship.

## Lycoming Plans to Develop Family of Gas



PRODUCTION LINE FOR T55 outboard engines is shown from overhead, above left. Right, vertical two stand with spinning T55 is used to check characteristics of propeller through speed VTOL operations. Wing can be geared during engine run.



PRODUCTION STAGES FOR T55 ENGINES are shown at Stratford, Conn. Production rate of T55 engines is expected to increase by about two and one-half times and production rate of T55-L-5 engine also is expected to increase.

## Turbines for Aircraft, Industrial Uses

By David A. Anderson

Stratford, Conn.—Lycoming Division of Aero Corp. is developing an T55/T55 gas turbine series to meet military and expanded applications by fully carrying a future price tag of \$55 per horsepower.

The division plans to start with the "small" gas turbine, which range up to either 5000 hp or 1200 lb thrust and to develop in that range, a family of engines for civil and military aircraft, industrial and marine powerplants.

Based for the development program is the current series of T55 and T55 gas turbine engines, being built in large quantities primarily as helicopter powerplants. Future engines will include turboshaft, turboprop and turbofan types, and will deliver horsepower approaching the 4000 mark, and thrust loads near 5000 lb. With this expanded performance will come reduced specific fuel consumption and improved power weight ratios.

### Current Production

Most of Lycoming's current production of gas turbine engines is in the T55 series, with the T55-L-2 and T55-L-5 the major items. Production rate of these engines, already high, is expected to increase by two and one-half times soon so that the line will be

turning out several engines per working day. Piled on this will be the increasing load of the T55-L-5 engine now in moderate production.

Locating built a large portion of its reputation on piston engines, and they still account for a good portion of the corporate income. But developments in the piston engine have leveled out, and today's engine improvements rest about the best the state-of-the-art will permit. Consequently, there is not much future research and development aimed at improvements in the piston engine.

But that background, plus the experience Lycoming has had as a prime producer of Wright engines, have taught company production men the ways to reduce costs processing of machined parts. Lycoming has more than 5,000 K1150 and K1150 piston engines under license from Wright Aeronautical Corp. This was produced for the lowest cost referred to in the entire production program for these engines, which were built in several locations including the Wright plant.

The kind of experience, plus the performance of its current crop of gas turbine engines, plus Lycoming captures the best for their production of some power for low cost.

They point to their experience on the T55 contract as one specific example of the division's capability. The

program was bid as a fixed-price contract for \$2.2 million, and it was probably the last engine to be financed that way in the country. Along the way the requirements were changed. The engine had to be qualified in a 150 hr. test, not a 10 hr. test. Its power was increased from 1,050 to 2,200 hp for island. It had started as a geared engine, and was to be changed to an unground, lagged output shaft engine. An integral oil return had to be incorporated.

### Leitner Funds

At the end of the 10-hr. qualification, there was money left over which was referred to the government. Since then, the division has offered several other programs on a comparable basis with a Leitner bid. Seven engines are now on contract with the division.

• T55-L-1A and -1B, powerplants for the Army's Bell H-101A helicopter and the USAF's Kaman H-43B helicopter. In the Army-1A engines, the time between overhaul is 500 hr., for the USAF-1B engines, that time is 600 hr. Engine has a shaft horsepower rating of 500 hp, and a radial thrust of 182 lb, for an equivalent shaft horsepower of 501. Equivalent specific fuel consumption is 0.775 lb/hp/hr. The engine weighs 404 lb. dry.

• T55-L-2, powerplant for the Army's

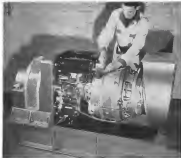


## K 1500 automatic electronic switching systems

The K-1500 series is designed for advanced communications use by government and the military. This fully transistorized two or four wire system combines the advantages of space division in the voice paths and time division in the control circuits. Replacing a roomful of sprawling equipment, the K-1500 series simplifies and expedites the switching of both vocal and coded data communications. The completely self-contained system occupies as little space as two 4-drawer file cabinets, operates on as little power as a television set, and can be installed in a matter of hours. The K-1500 is easy to operate; the color-coded, condenser-stamped circuit boards shows the operator what to do at any given time. The K-1500 is easily maintained; standardized solid state circuitry is on interchangeable printed circuit cards. The K-1500 is nearly expandable; one of the many benefits of modular construction. The system can be expanded to accommodate any number of lines for intra unit and outside calls—and is not affected by environmental variations. Unique proven logic concepts and features assure that the K-1500 is ready, now, to do your communications job.

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**MARINE VERSION** of Lycoming gas turbine engine, ideal in applications to Navy amphibious vehicles, represents one of General's hopes for large future market.

General AG-1 Midland. The engine has a 600-hp TBO. It is rated at 960 shp plus 113 lb axial thrust for takeoff, for an equivalent shp of 1,085. Equivalent shp is 0.675. The engine weighs 324 lb.

• **T53-L6**, powerplant for the Army's Bell HU-1B helicopter. This version of the basic engine develops 1,005 shp, but has a higher equivalent specific fuel consumption than the T-1. Figure is 0.684 lb/shp-hr. The engine weighs 457 lb, and has a 400-hr TBO.

• **T53-L7**, powerplant scheduled for later version of the AG-1. This engine has 1,190 shp for takeoff, with a corresponding specific fuel consumption of 0.644 lb/shp-hr. It has recently completed its 150-hr qualification test. Dry weight of the powerplant is 340 lb.

• **T53-L9**, powerplant for the Army's Bell HU-1D and which will become of interest as powerplant for the HU-1B also. This engine carries the 1,118

shp rating for takeoff, with a corresponding specific fuel consumption at 0.652 lb/shp-hr. Dry weight is 495 lb. It has current service with a 400-hr TBO. This powerplant has been certified by the Federal Aviation Agency as the T539A, and will be used in the converted Bell Model 204B.

• **T53-L11**, powerplant to be phased into the Bell HU-1D. This engine completed its 150-hr qualification test, mostly at its design rating of 8,150 shp, for takeoff. Equivalent specific fuel consumption was 0.652 lb/shp-hr.

• **T53-L12**, powerplant for the Veeol Conquest helicopter and the Cessna X-19 VTOL aircraft. This engine, which has completed a 150-hr qualification at an uprated power of 2,850 shp, is normally rated at 2,250 shp, mainly. Equivalent specific fuel consumption is 0.648 lb/shp-hr. Engine has a preliminary TBO of 150 hr, but

## Advanced T53 Engine Series

Existing Model	L1C10-5	LYC60-3	LYC61-4	LYC101-5	FL101A-1
Type of application	Helicopter	Helicopter	Helicopter	Turboprop	Turboprop
Takeoff shp, hp	1,491	1,100	1,490	1,890	—
Max thrust, lb	215*	145*	135*	115*	1,340
Design shp, hp	35,180	5,770	6,500	1,621	—
Dry weight, lb	472	321	321	379	618

**Remarks:** In advanced research and development, aiming at test stands, improved components, development by Lycoming and permanent testing, are major features.  
\* Revised thrust.

Design Only



## PUMP PRIMERS

ARTICLE • 11/10/15

### Better Pump Reliability In Severe Environments

Engineers concerned with driven, modular power systems, drive issues and various transmission design problems involving pressure lubrication have found General's pumps extremely useful in their attempts to hold weight down and achieve maximum compactness with high service reliability.

These pumps are positive displacement types internally design, vibration balanced and quiet. In severe environments they prove exceptionally reliable.

The Genitor is a form of internal drive pump consisting of two main parts: an inner locked element and an outer, rotating locked element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber in which the fluid from the inlet port to the outlet after Figure 11. Pump capacity is increased by the volume of the "missing tooth" displaced by the rotating inner and outer parts.



FIG. 1

Low relative speed and closely held tolerances between the two Genitor elements assure ideal volumetric efficiency in applications.

Flow capacity of the Genitor is increased by the large inlet and discharge ports which are in addition to the main shaft rapid pressure change and turbulence which, in other types of pumps, results in heating and lowered efficiency. Thus, Genitor pumps deliver maximum performance at high speeds.

Engineers find the Genitor pump most valuable because there are several inherent variables that can be adjusted to meet the application requirements. Genitor pumps which deviate the size of the pumping chamber, Genitor pumps which, taken with any, deliver more volume per revolution and R.P.M. Thus, it is possible to vary the chamber length and speed of the pump elements to create wanted capacity. In addition, the surface of the type of pump is completely flexible in design, making for ease of fitting adaptability to the multiple shape and geometry of the engine situation.

Technical data is available and your inquiry is invited. Write:

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In these vital defense areas TRANSACTION input stations — located throughout engine, air frame, instrument and avionics divisions — are continuously reporting overhaul progress and status in the interest of fast "turn around" and return to duty of the world's most effective manned Naval weapons.

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specific engines have been run more than 675 hr after a major overhaul without showing need for major run down.

Beyond these seven are 11 advanced engine developments of both the T55 and the T56, which are, in varying degree, available. Component development has been done for several (two hours) and others have been run on the test stand. The primary objective now is to get orders for them.

Most exciting of the T55 developments is under way at the LTCM's turboprop engine rated at 3,935 shp. This engine has been running for about one year now, using a split power gas system to distribute the loads on the gearbox and improve the life of gears. In principle, the torque is fed from the high-speed engine shaft to a first stage of gears which transmit about one third of the input power directly to the propeller shaft before it enters the second stage of gearing. This reduces the loads on the second stage, so that the designer can then trade off weight for gear life. This lowering development is proprietary and patents have been applied for. All the work was completed.

### VTOL Test Stand

Ltjens had had a continuing program of testing engines to validate VTOL operation using a special test stand which can rotate the running engine through a range of positions corresponding to those expected in VTOL launch.

Work started with a T55-3 on engine mounted in a complete aircraft on

a craft wing section. The wing section was pivoted on the test stand so that it could be swung through the angle simulating transition from vertical takeoff to horizontal flight. The engine was completely modified to handle the different operational loads: the main bearings were sealed with petroleum test oil, and a scavenging pump was added to the accessory gear box to scavenge No. 3 and 4 bearings.

Apparently the only problem with the vertical operation of the engine occurred during shut-down, the engine cooled. Bearing temperatures were normal, there was no apparent interest in heat rejection to the oil. There is difficulty in starting the engine in a warm position or in intermediate attitudes between vertical and horizontal.

Learning looks to the future and industrial market as a major future source of orders and income. One engine close to the program between the divisions will be doing much of its 1964-1966 business in this area.

Potential market is primarily Navy amphibious vehicles, and Ltjens sees the possibility of sizable orders beginning in about two years for engines for these kinds of vehicles. One estimate is that the number of powerplants for that market will equal the number of heli-copters being sold during the same time period.

The division is competing with both Solar and Pratt & Whitney, relative old-timers in the industrial gas turbine business. Both have solid numbers of orders for the power turbines.

Learning intends to work in the horsepower range between 1,000 and

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Thermocouple Thermometers

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Winged  
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3/8" x 1/2"  
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Engineered to give years of service in test work as well as permanent installations, LEWIS switches have heavy, low-inertia cast metal, perfect detail finish and sturdy terminals for easy wiring.

The cases are splash proof and dust tight of close fitting bakelite. Heavy black-finished aluminum mounting brackets are used to keep the standard coil switch supporting the sensing element.

### RESISTANCE RAIL SWITCHES

A complete line of the same construction except that they are fitted with a common terminal rail for three-way bulb connections.

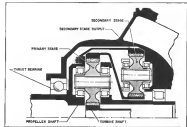
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Small, sturdy, shock-mounted resistors 1 1/2 inches in diameter, 2 1/2 inches total shaft length, one hole mounting with 1/32 NPT hole. Designed especially for controlling two or more resistance temperature detectors in one structure, now flying in the modern jets.

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Specialties in Temperature Measurement  
HAUSTON, TEXAS



CROSS-SECTION through Lycoming split-power gas system shows the layout of the different approach to gas turbine power. Turbine shaft drives propeller stage including gearbox, which in turn drives a secondary stage reduction gear. Output from the secondary stage drives the propeller shaft through a large coupling bolted to the shaft.

## SPACE TRAVEL IS A PEOPLE BUSINESS

While space travel is a domestic industry, it is also an international one. It is an industry that is growing at an extraordinary rate. The growth is in the number of people who are working in the industry, in the number of people who are working in the industry, in the number of people who are working in the industry. The growth is in the number of people who are working in the industry, in the number of people who are working in the industry, in the number of people who are working in the industry. The growth is in the number of people who are working in the industry, in the number of people who are working in the industry, in the number of people who are working in the industry.

**AEROSPACE DIVISION**  
Personnel Dept.,  
Box 22070,  
Los Angeles 22, California

For more detailed information, write to:

Attn: Recruitment Specialist



**LYCOMING T55 ENGINES** are assembled on this tool box before being run and accepted. Rotomold holding fixtures are used for convenience.

2,000, with a possible stretch as high as 3,000 hp. The engine can still be competitive at that rating.

The projects are based primarily on the T55 and T55 series of engines which have been adapted for marine and industrial use. In modification, Lycoming has been successful in the top of the engine for aircraft. There are now four and one-half engines, the former combining the air inlet and exhaust.

The industrial engine is designed around a turbopropeller and an exhaust system on a Diesel fuel. Lycoming officials also expect to develop a marine engine.

• **TF-1490**, a marine version of the T55, rated at up to 3,200 hp. It weighs 1,200 lb., complete with accessories and gear box. It is currently the powerplant in the Lycoming LNH-1 landing-lift amphibious vehicle using a hydrofoil system.

• **TF-3856**, a marine version of the

T55, rated at 1,500 hp. It is being used as the powerplant for a vehicle equipped with the LNH-1, the Borg-Warner LNH-1, built around the standard belt system.

As a result, the industrial field started about 10 months ago with an adaptation of the T55, and then the work later expanded to include the T55 engine.

The tendency of most observers is to concentrate on Lycoming's position as an engine manufacturer and to overlook the capabilities of the mass of machines that utilize the engine. A major portion of its revenue comes from sales of engines, the fabrication of large or difficult or unusual parts or sub-assemblies, generally made at once or on-site applications.

The Standard plant currently is building the ML-4, ML-5 and ML-11 re-entry vehicles used on Titan I, Minuteman and advanced Minuteman re-



## Navy Launches Q-2C

First launch of a Navy Q-2C by Navy personnel at Ft. Myers, Calif. is shown. Launches a few 11,000 lb. these JATO suit. Missile was about 44 min.

entry. These re-entry bodies were developed by Aero's Research and Advanced Development Division. One indication of the volume of work involved in the dollar value of the contract for the ML-11 body. Value is \$14,500,000.

## Minuteman Work

In addition, Lycoming is manufacturing second-stage rocket motor divisions for the Minuteman for delivery to Aerojet General. These chambers are now being built from both steel and titanium, but indications are that the titanium will be substituted at some point in future production. Work is also in progress on the cylindrical air section, and both upper and lower air section sections.

However, the work does not include the nozzle.

At one time, Lycoming was producing

engines for all three stages of the Minuteman, but the ML-5 re-entry vehicle is now phased out of some of that work, making the production of second-stage engines for the Polaris missile and work on the Nike-Hercules and the Titan.

## Rocket Motor Chambers

Now on the shop floor, in addition to Minuteman production, are solid motor chambers for the acceleration rocket of the X-20 Dyna-Son. These are not too different from a conventional Minuteman second-stage engine. The dynamo is also building nose and conical nose sections for the Martin B-26 propellers.

Lycoming is also a subcontractor to Wright Aircraft Division on the first stage Minuteman motor casing, supplying complete disassembled chambers to the company. Also in production are spherical rocket motor cases being built for Throckley. The rocket motor chambers eventually will be used in the Saturn space vehicle.

Large portions of this type of work is done with a bank of three driven screw milling machines controlled by punched tape, IBM card, or template. There is a long slide of these machines in the Standard plant, probably the largest group of these machines in the United States.

Lycoming has also won a reputation as a developer of lubrication techniques. One current contract, recently received from Aeronautical Systems Division of Air Force Systems Command, calls for the development of new 4-ft.-dia., 10-lb. roller bearings made of high-strength steel, used in the autostart automatic condition.

These exact are the same size as those for the second stage of the Minuteman B-26H.

## NEW CONCEPTS IN HIGH FREQUENCY

**TRANSISTORIZATION** enables electronic circuits and assemblies to handle high frequency signals at rates of up to 100 GHz. This is a major advance in high frequency performance in large scale systems of a very small size. Transistors are now being used in a variety of applications to get better performance in high frequency systems. This is a major advance in high frequency performance in large scale systems of a very small size.

An ideal answer for the coupling of high frequency signals between stages is to use a single stage coupling. This is a major advance in high frequency performance in large scale systems of a very small size.

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## Hercules Shows STOL Capability

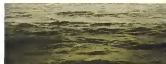
Modified Lockheed C-130 Hercules transport demonstrates its short-field capability by taking off from rough field over obstacle. Modifications include increased flap spreading rate and deflection, increased aileron and aileron chord and addition of a flap parabola in last section of the aileron.

## Advanced T55 Engine Series

Lycoming Model	GT404-B	LT404-F	LT404-G	GT404-Z	P470-B-1	LT404-1
Type of application	Marine/propeller	Marine/propeller	Marine/propeller	Marine/propeller	Turboprop	Turboprop
Takeoff shaft hp	2,000*	2,400	2,400	2,400	2,400	2,400
Max. thrust, lb.	2,000*	2,400	2,400	2,400	2,400	2,400
Output shaft rpm	16,000*	16,000	16,000	16,000	16,000	16,000
Dry weight, lb.	1,200	1,200	1,200	1,200	1,200	1,200
Dimensions	60 in. x 60 in. x 60 in.	60 in. x 60 in. x 60 in.	60 in. x 60 in. x 60 in.	60 in. x 60 in. x 60 in.	60 in. x 60 in. x 60 in.	60 in. x 60 in. x 60 in.

\* Military ratings; takeoff not available.

† Restricted thrust.



## ON WATCH:

The Navy's anti-submarine warfare task is no longer confined to protecting our ships from enemy raiders. Now our cities—even those far inland—face potential danger from sub-launched nuclear missiles. Helping the Navy maintain alert watch over America's more than 14,000 miles of coastline—as well as the vital sea

lanes of the world—is the Lockheed P3V Orion. The big 400-ton Orion is the deadliest combination of man, electronics, and armament ever pitted against a submarine.

The P3V Orion is just one way Lockheed is working to help the Navy in its fantastically complex job of detecting, locating, and tracking hostile submarines.

the Navy's new P3V roams vast reaches of the sea to keep hostile subs at bay

Six of Lockheed's divisions are deeply immersed in ASW and related phases of oceanography. Lockheed researchers are probing subjects like underwater sound propagation and scattering; temperature gradient effects; sound transmission through the interface of the ocean and the atmosphere; and sea-bottom

effects on sound transmission. They even record and analyze the sounds made by undersea creatures.

Lockheed's Anti-Submarine Warfare and Ocean Systems group coordinates a corporation-wide effort that runs broad and deep—from the depths to the surface to the aerospace above.

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1. Beech Aircraft has successfully hydrotested a 7,000 gallon welded titanium tank, produced under an Edwards AFB contract.
2. Titanium Metals Corporation of America has introduced titanium alloy components modified especially for liquid hydrogen service. You'll have to know as much as possible about them — as fast as possible — to keep ahead of the LH<sub>2</sub> field. TMCA can help you here.

**One-third lighter than stainless.** The Beech titanium test vessel measures eight feet in diameter by 24 feet in length. Although its weight is diminished, it weighs almost one third less than a theoretical optimum stainless steel alternative.

The success of the titanium test tank — the largest assembly of its type yet built — makes even larger vessels practical. It was fabricated from sheet supplied by TMCA to less than AISI tolerances, in thicknesses ranging from 0.016 to 0.025 inches. Beech reports that the weight of this titanium test vessel could be reduced by 50%, by using even lighter-gauge sheet and designing with titanium's high strength and ductility at liquid hydrogen temperatures.

**Titanium grades for liquid hydrogen.** Titanium Metals Corporation of America has introduced two grades of titanium modified specifically for service at liquid hydrogen temperatures. They are the "ELI" (Extra-Low Interstitial) grades, Ti-6Al-4V ELI and Ti-5Al-2.5Sn ELI. The Beech tank was produced of Ti-6Al-4V ELI. Both alloys have strength-to-weight

Table I — Typical Tensile Properties of Ti-6Al-4V ELI

	Test Temperature		
	70°F	-320°F	-423°F
Yield strength, psi	182,000	161,000	204,000
Tensile strength, psi	117,000	181,000	209,000
Elongation, %	16.5	19.0	15.0
Retained Tensile Strength, psi	181,000	209,000	221,000
Retained Unstretched Res.	1.35	1.29	1.53

Table II — Typical Tensile Properties of Ti-5Al-2.5Sn ELI

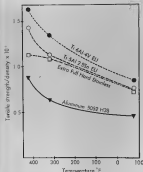
	Test Temperature		
	70°F	-320°F	-423°F
Yield strength, psi	137,000	220,000	241,000
Tensile strength, psi	136,000	211,000	263,000
Elongation, %	14.0	15.0	7.0
Retained Tensile Strength, psi	145,000	206,000	211,000
Retained Unstretched Res.	1.21	0.94	0.90

ratio at cryogenic temperatures that are superior to stainless steel and aluminum (see Figure 1). At the same time they retain toughness — a fact that few materials can approach. Control of interstitials also enhances the rolling characteristics of the grades in production of wide, thin sheets needed for LH<sub>2</sub> programs. For example, material is now available in such representative sizes as 0.014 x 24 in. x coil and 0.036 x 48 x 120 in.

**TMCA your best bet in titanium.** The best bet today for cryogenic vessels in high-energy missiles is titanium. Its successful fabrication in large tankage, such as the Beech tank, underscores the fact that three-grade titanium sheet is here. And if your best bet is titanium, then TMCA is your best bet in titanium. TMCA is the nation's only company devoted exclusively to titanium and is the only organization with the experience provided by an unbiased history of full-time technical assistance.



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Comparison of strength-to-weight ratios of aluminum, stainless steel and titanium

Figure 1. Curves show superiority of new ELI grades of titanium to stainless steel and aluminum, on a strength-to-weight basis. Colored Ti-5Al-2.5Sn ELI and Ti-6Al-4V ELI (for extra low interstitials) are cryogenic titanium grades that retain toughness at low temperatures and impermeability to hydrogen.

Largest titanium assembly ever made, the 7,000 gallon test vessel designed and produced by Beech Aircraft, measures 8 feet in diameter by 24 feet in length.



# "INFRA EYE"

## Honeywell Photoconductive Infrared Detector



New capabilities in pinpoint photo reconnaissance are now made possible by Honeywell's Photoconductive IR Detector. Systems utilizing the high responsiveness and detectivities of this unique indium antimonide detector produce highest resolution infrared maps.

Available now in production quantities, this new IR Detector offers performance characteristics and design flexibility previously unavailable to photo-reconnaissance systems designers. Special

integrally cooled Dewar designs are also available. For details, contact your nearest Honeywell representative, or write: Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass. Dept. AW-15.

## Honeywell

**Military Products Group**

Circle 101 & 102 on Reader Service

allow a cold reduced to 60% for example, margin for error with the non-common materials.

NASA has had a program under way for about 14 years to compile data on most of the alloys under consideration. Ductile break without cause of the basic findings for each of the three categories.

• **Steel-Preparation**—Heat-treated stainless steels can be produced with tensile strength as high as 300,000 psi in the cold worked condition. These are rated at top temperatures of 900° but tend to be lowered by their creep strength. Stainless steel AISI 304 is one of the most promising because of the very high strength obtained when it is cold worked to about 60%.

• **Aluminum alloys**—These alloys generally are considered to have top temperature use of about 500° and direct angle safety margin for use on portions of the SST. Typical alloys in the alpha phase and all beta exposures are included with the highly stable alpha alloys showing some variations.

• **Superalloys**—These nickel, cobalt and iron base alloys at first do not appear suitable because they are expensive and difficult to fabricate, particularly in the cold worked condition in which their best properties are obtained. The alloys were designed for very high temperatures, however, and therefore still have application now in the hot resistant areas. Their stability and elevated strength also make them attractive for use in the 500 to 600° area as well.

Materials would like to let the airplane manufacturers incorporate them with the mechanical properties of each alloy and make a selection on that basis. Ductility and "unforeseen" creep tests, mechanical property data tests only for these materials, especially for the life span and temperature range involved.

To compile some of this data, NASA has been conducting a screening program to avoid use of the less promising alloys. Toughness was evaluated by using the standard ASTM edge notch tests, test stability in mechanical properties are studied by successive tensile strength after 1,000 hr. service load at 650° and corrosion susceptibility was evaluated by salt water tests.

Complete data on these NASA tests should be available in the first of the year.

In addition to this the NASA materials group has drawn up a new formula for evaluating the alloys which passed the screening tests. Ductility characteristics on a break the alloy using a bend are tested on a duct in two categories.

The first category is called the "go-go" category and in it alloys are rated on how easily they can be welded and brazed and how they react chemically. If

## Stepping into Space



... at supersonic speeds



Rocket System



Piston Engines



Turbo



Piston Engines



Piston Engines



Piston Engines



Piston Engines

Ejection of the first manned Stearman Avian capsule at 345 mph from a General Dynamics B-36 was a milestone in aviation safety. Since that day in March, 1952, continued refinement of this escape system has culminated in an operational device now in squadron service and meeting the full performance maps of the B-36.

An important part of this system is the Aerotec composite disconnect which (1) automatically separates six gasless services and 26 electrical contacts between aircraft and capsule during ejection, (2) incorporates shut-off valves and balanced lines to accommodate high pressure gases, a flowing heater for bleed air and a positive lock to prevent relative movement and wear of the assemblies.

Aerotec's capabilities in developing qualified composite disconnects and other components or systems that control or sense pressures and liquid pressures and levels makes an understanding of your problem. Write to Aerotec Equipment Division, Aerotec Industries, Inc., Dept. AW, Greenwich, Connecticut. In Canada: E. C. Chown Limited, Montreal & Toronto.



**AEROTEC INDUSTRIES, INC.**

ANEROTEC INDUSTRIES, INC. IS A DIVISION OF AEROTEC INDUSTRIES, INC.

RESEARCH DIVISION: Aircraft Engines, Pumps and Gear Boxes

INDUSTRIAL DIVISION: Fluid Control Systems, the Standard Zero State

and other equipment.



Full (1000X) micrograph of a stainless steel surface, showing the fine, regular, circular, or hexagonal, fine-grained structure of a metal. The surface is covered with a fine, regular, circular, or hexagonal, fine-grained structure of a metal. The surface is covered with a fine, regular, circular, or hexagonal, fine-grained structure of a metal.

Good trip up  
Now analyzing 28 elements  
Complete report being  
transmitted  
GC\*

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Each



Enter Gas Chromatograph—  
a precision analyzer in a tiny package  
suitable for AUSA, JPL,  
in cooperation with Propper Develop.

Designed to travel on the initial moment, a Beckman gas chromatograph will go to work, analyzing 18 constituents of elements of linear extent stepped up and fed to the little line.

In 1961, when NASA JPL asked Beckman to take on the job, it meant creating precision equipment that could face the pull of 300 g, undergo the deep freeze of lunar night, and make analyses on solids rather than gases.

Beckman—leaders in infrared, mass spectrometry, and gas chromatography—weighed the virtues of all three techniques. The findings for spectrometry experiments, like gas chromatography is best. It's unaffected for magnitude, simplicity of design, environmental stability.

The latest chromatograph gives the first indication of the spaceborne gas chromatograph's potential. Tomorrow, the life support system for lunar flight will depend even more on the precision performance of Beckman's chromatograph. For complete information on space age gas analysis, write to Manager, General Sales.

Beckman also stresses space application in solid state processing, metal analysis, infrared, light analysis in monitoring, additive analysis, and a complete list of services.

Beckman

INSTRUMENTS, INC.  
Fullerton, California

an alloy, into poorly on any of the three requirements it is illustrated. Those which pass the requirements of the first criterion are then rated in the second on eight other characteristics: strength, toughness, softness, stability, fatigue resistance, as welded strength, thermal stress and cost.

Numbered from 1 through 5 are used to designate both the importance of each characteristic and to indicate the extent to which the alloy exhibits each characteristic. In compiling the totals, an overall index number is obtained for each alloy.

#### Final Selection

Details and the basis for the final selection process will be the next to be planned and detailed data available at the time. By and additional information is needed in later work area.

• Low static rate creep—Materials selection thus far has been made with the fact assumption that no creep will take place. Under constant exposure to the fluctuating temperatures that will be found on the SST, however, creep may become a factor and it should be further investigated.

• Toughness—A switch should be made from static strength testing to a more one based on fracture mechanics of equal importance in the extension of testing to wide sheets ranging in thickness from 1/8 in. to 1/2 in. and in lengths from 10 to 20 in. on which most testing has been done.

• Corrosion—This question requires much more investigation than has been planned. It is possible protective coatings to meet the heat environment, and second, to evaluate alloy stress corrosion characteristics under such simulated operating conditions.

• Fatigue—Data on fatigue characteristics over the entire temperature range in particular stability. Past experience indicates that the data is of greater utility if it is obtained by using loading spectra and temperature cycles that simulate actual usage.

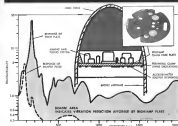
#### RS-70 Program

Details and information of a general nature will be derived from the RS-70 program. The RS-70 program, but the operating parameters and life expectancy of the two aircraft are so different they cannot be made comparable.

Basic data on the fabrication of air affect the construction of large, low-cost joints and the development of protective coatings for hydrocarbon stress loading gear and fuel tanks as well as when the SST will benefit from the RS-70.

Studies of noise and traffic control problems with the RS-70 also will provide valuable in developing SST design and operating concepts.

## BARRY DAMPING IN ACTION



Adding stiffness (and that usually means mass) is seldom a satisfactory answer to the problem of structural response to shock and vibration. Adding damping is a much more practical solution.

Now Barry Controls offers two types of damping... the original RIGIDAMP technique, and a new pressure-sensitive additive damping.

RIGIDAMP structures, with built-in damping have proven time and again that you can have lightweight structures and controlled dynamic response.

For example, the curve above compares the transmissibility of an undamped mounting plate for an engine and firing system to its RIGIDAMP replacement. The shaded area represents reliability for critical plate mounted components... com-

puted response in launch condition and in flight vibration... and a reduction in resonant amplification from 40:1 to 5:1! All at no increase in weight! For a technical analysis of the solution to this mounting plate problem, ask for Case History EA 2061.

If you're concerned with the behavior of simple or complex structures in dynamic environments... if structural fatigue, noise transmission, high acceleration levels, or improved reliability are problems to you... ask for more information about Barry damping techniques. Data Sheet AI 1562, "additive damping for exciting structures". Bulletin 60-45, "RIGIDAMP technique for better damping". Just write, Barry Controls, 700 Pleasant Street, Watertown, Mass., or 1400 Flower Street, Glendale, California.



Rigidamp integral damping



Pressure-sensitive additive damping

SHOCK, VIBRATION AND NOISE CONTROL

**BARRY B CONTROLS**

A Division of Barry Controls Corporation



Flite and maintenance crew are in this RCNCF/McDonnell CF-101B Voodoo jet interceptor during a post-flight assembly for Nand exercise.

## RCAF Squadrons Flying CF-101B Interceptors



Personal performance checks on CF-101Bs at Ottawa return post before start of a mission, above. Turnaround crew demonstration, below, shows rapid loading of Hughes Falcon action modules on the aircraft.



It is fast RCNCF interceptors jet intercept.

## In Norad Support

Five Royal Canadian Air Force squadrons are now flying the McDonnell CF-101B Voodoo interceptors as part of RCNCF's North American Air Defense Command (NORAD) operations. Squadrons are located in Ontario, British Columbia, Quebec and New Brunswick. The two-man, all-weather interceptors have a payload of 10,000 lb. in RCNCF (AW) No. 12, 13, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. The aircraft is powered by two Pratt & Whitney J57 engines producing more than 10,000 lb. of thrust with afterburners. Maximum speed is more than 1,200 mph, and peak operational altitude is above 50,000 ft.



Ground personnel stand away from CF-101B, above, as safety precaution during liquid oxygen loading. Dog chain landing is shown below.





## RAAF Gets First Bell HU-1B Rescue Helicopter

Fast at right: Bell HU-1B helicopter, painted olive with Dingo high-visibility markings was delivered recently to Royal Australian Air Force. Remaining crew will be standard olive drab. Helicopters will be used by Search & Rescue Squadron 9. This is value of contract was about \$4 million. Photo and ground crew received training at Fort Rucker, Ala. and at Bell's Fort Worth, Tex. factory. Composite view of instrument panel shows differences between pilot (right side) and copilot (left). Primary difference between this aircraft and those assigned to U.S. Army is electronic control panel, below right and various equipment. There are 680 in total and engine exhaust control device for dumping fuel in an emergency. Avionics installation is shown below left.



minus one for paper

	S	P	R
S	0	1	-3
P	-1	0	1
R	1	-1	0

The payoffs are known. The Scissors-Paper-Rock game matrix\* provides a mathematical abstraction of the conflict situation. Now a Game Theory analysis can be performed. Its objective is to answer the question of how best to play the game. Strategy options in real-life conflicts are exceedingly more complex. To select the optimal course of action is the major move in our global game. To this end our engineers design command and control systems today for tomorrow's offensive and defensive moves. If you seek to devote your scientific skills to determining long-range strategies and their associated tactical systems, you will find us generally receptive to your original thinking. Engineers, mathematicians, and scientists are cordially invited to apply. A good first move would be to send your résumé to Mr. Harry A. Lear at 6700 Elan Avenue, Canoga Park, California. He will counter with an immediate response. Litton Systems, Inc. is an equal opportunity employer.

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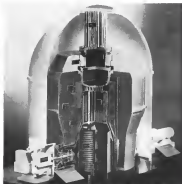
How about applications in your field of interest? For more information or for a discussion on how depleted uranium metal may fit your design needs, write or call:

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**DEPLETED URANIUM METAL**



MODEL OF NUCLEAR shows quantities built in. GE for maximum use shows reactor core set above the boiler. Air is heated to 1,300° in the reactor and circulated through the boiler, producing steam. Section is rated at 30,000 shp.

## Testing Set for Engine Developed From Nuclear Aircraft Program

New York-New, nuclear nuclear prototype developed by General Electric Co. from experimental nuclear engines originally designed for the new defense Aircraft Nuclear Propulsion (ANP) program is scheduled to begin test operations this week.

Testing of the nuclear steam generator developed by GE will be done at Atomic Energy Commission's National Reactor Testing Station in Idaho. The station, 14 ft. high and 18 ft. dia., weighs 540 tons and will develop 75,000 shp, according to Ben Rosenberg, manager of the GEAN development program.

Fast now with the AEC-funded engine will be engine experiments to prove the safety of the engine's design, according to Rosenberg. Power output will be low.

Rosenberg said the new engine is based primarily on GE's Heat Transfer Reactor Experiments (HTRE) 1 engine built in 1955, although it draws on technical advances made with 11 fast engines developed for the ANP program between 1945 and 1955.

It is a closed cycle unit consisting of a water-moderated reactor set above a steam boiler. The reactor, heated with 97% enriched U-235, replaces the burner in a conventional oil-fueled boiler. The fuel elements are designed for a 15,000 hr life.

Air is heated to 1,200° in the reactor and circulated down through a boiler, superheater, which produces 950° steam at 550 psi. After the air has passed through the boiler cycle, it is recirculated through the reactor by a blower.

"Using air as the working fluid has made possible improved performance over the high-pressure water systems used in other nuclear engines," Rosenberg said. "We can heat the air to 1,300° as opposed to 700° which is the maximum temperature that can be attained with a pressurized water system."

Rosenberg said the air system had two other advantages—increased safety and a growth potential factor.

The circulating air, in addition to

How many things can TRANS-SONICS, INC. serve you?



## INITIAL GUIDANCE SYSTEM

Life won't be different in the second half of the 21st century, when the world will be a flat — as evidenced by this early Pictorial American history.

Life will be different, however, but not the search for something new and useful.

Today's computer systems in dynamic systems are based on today's, and yesterday's experience in design, test, and evaluation. Their performance is based on a "flat" for the past, and the future that comes with safety and time.

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**THESE VEHICLES**  
(and many more)  
**USE**  
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**SWITCHES AND**  
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As the cost and complexity of aircraft and space programs trend upward—in aerospace's insistence on maximum reliability and perfection in all components. The result? Aerospace manufacturers select Cutler-Hammer as the preferred source for aircraft switches and power relays.

Proven on thousands of military and commercial aircraft, in space and ground support applications—this leadership dates back to 1920 when Cutler-Hammer created the first line of switches specifically designed for airborne application.

Each line has been meticulously designed—each device is critically manufactured, assembled, inspected and rigorously tested. Whether it's a switch, a circuit breaker, a Class D or hermetically-sealed power relay—you're assured of Cutler-Hammer's years-ahead design, manufacturing excellence, consistent quality, positive performance and rapid availability.

Need a special switch or power relay to solve a particular problem? For really fast service, call your nearest Cutler-Hammer sales office. And for detailed information on our broad, popular lines of aircraft switches and power relays—write for our new 40-page catalog, publication LU-506.

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## AT RADIATION, IDEAS BECOME REALITY

### Example: Telstar's 8 W/112 channel PCM telemetry system

Bell System's Telstar is coming, success—in a space environment that threatens the Van Allen Belt—not only poses the feasibility of voice satellite communications, but also the reliability of a new telemetry technique. PCM telemetry has now won its spurs as the most advanced method of checking satellite performance.

Telstar's PCM system, built by Radiation-McBourne for Bell Telephone Laboratories, weighs only 8 pounds, requires less than 430 milliwatts of power... yet provides 112 information channels in 8 MHz of capacity available today. Channel allocations: 16 voltage, 40 temperature, 9 current, 27 resistance, approximately 2 pressure, 18 solar current, and 8 relay status.

Size enables all Telstar's telemetry data—received by the Radiation-designed and built command tracking antenna—indicates the carrier pressure is still above 5.0 psi, showing that the center has not been punctured; average ionospheric noise of 25°; average ion temperature of 20°; solar cells delivering 0.5 amp at 13.5 W; and a radiation-

induced decrease in current output of 15% I/FB with 20 mR alpha is shielded semiconductor and 5% I/FB with 25 or 30 mR gamma shielding.

This important new telemetry technique is only one of many advanced projects on which Radiation scientists are now working. If you like to explore advanced concepts, you'll find a stimulating and challenging environment at Radiation... where ideas become reality. Send your resume or write for more information Personnel Director, Dept. AW-101, Radiation-McBourne, Melrose, Massachusetts.

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**RADIATION**  
McBourne

Chemical-free system—Data acquisition and processing—Active shield—35 systems—Shielding

ating in the working fluid also has an external shielding use. If a fluid element should spend a leak, an auxiliary blower can be used to increase the volume of air circulating and prevent overheating for a longer time than the circulating water system.

### Gas Turbine Yarns

The 60A, although designed to fit present merchant ships with fairly steady loads, can easily be adapted to a gas turbine version on the future. The fast air coming from the reactor will be used to directly power a turbine instead of producing steam.

In this version, the powerplant can be made small enough for use in high speed ketches and boats and in ground effect machines.

Cost of the 60A is less than one cent per horsepower installed, Blankenship said. The 60A will cost about \$1 million to construct with \$1 million for the system powering the N. S. Savannah, world's first nuclear powered merchant ship.

The Savannah's engine weighs 2,451 tons and develops 27,000 hp.

### ANP Termination

Blankenship and Glick decided to develop a complete engine incorporating the best parts of the overall engine design soon after the ANP program was terminated in April, 1961. After the Maritime Administration expressed interest in the first proposals in June, 1961, Glick undertook a feasibility study, which ran completed in February, 1962. Development of these components was carried on through the summer, with final results being accomplished at AFOSR before the visit.

Blankenship with the Maritime Administration is now meeting with shipbuilders to discuss a nuclear core program which will solve some of the design, test, and control problems which have plagued the N. S. Savannah program.

### AFOSR Grants

An AFOSR Office of Scientific Research has recently awarded 37 grants and contracts to colleges, universities, non-profit research organizations and several laboratories in this country and abroad.

#### RESEARCH

**University of Wisconsin, Madison** \$10—\$10,000 for research on solid-state and plasma-membrane solid-state semiconductor devices.

**New York University, Washington** \$10—\$10,000 for study of the effects of laser on the properties of solids and atomic nuclei.

**National Institute of Standards, Washington** \$10—\$10,000 for study of the properties of the N. S. Savannah.

**University of Utah, Salt Lake City, Utah** \$10—\$10,000 for research on heat transfer in

solids and variable liquid in reaction with gas phase. \$10,000 for study of the properties of solids and atomic nuclei and the effects of laser on the properties of solids and atomic nuclei.

**University of Chicago, Chicago, Ill.** \$10—\$10,000 for research on the properties of solids and atomic nuclei.

**State University, New York, New York** \$10—\$10,000 for research on the properties of solids and atomic nuclei.

**University of Illinois, Urbana, Ill.** \$10—\$10,000 for research on the properties of solids and atomic nuclei.

**University of Wisconsin, Madison, Wis.** \$10—\$10,000 for research on the properties of solids and atomic nuclei.

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DEVALVANCE'S T33 FUEL NOZZLE

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perience in large scale manufacturing of the intricate and precise parts that make up a fuel nozzle, and experience in controlling the quality and performance of these devices on a mass scale.

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tural to vehicle refueling in refueling and anti-aircraft defense which can be obtained by increasing the rate of change of distance traveled, Galle said.

An alternative design approach is to use a Schrienerman inertial navigation system for the trajectory vehicle, similar to most used for aircraft and submarines, which automatically establishes vehicle position. However, in this type system the stabilized platform oscillates about the vertical with an 18-in. period so that it is precisely correct only once every 12 min.

#### System Errors

With wheel indicator inertial platform system, error accumulates only as a function of distance traveled and not as a function of time, as with a Schrienerman system.

Thus, when the vehicle is stopped, the error buildup also stops.

Periodically, the MVRUM train port's error is expected to take it just one of more prearranged checkpoints, at which time accumulated errors can be eliminated.

Combining of stellar and inertial techniques in a single guidance system promises to provide "significant improvement in accuracy, reliability and response time," Bernard Lieberman of GFI's Aerospace Group said at the recent Inertial Guidance Test Sympo-

sium that was held at Holloman AFB. However, three potential advantages modern guidance systems encountered with all-inertial systems, Lieberman indicated. For example, a stellar-inertial system intended to provide guidance during the boost phase of a ballistic trajectory cannot be effectively evaluated by rocket sled tests, a convenient method long used to test all-inertial systems.

For an MVRUM application, stellar corrections to the inertial system would begin at altitudes of about 35,000 ft and continue until burnout at heights ranging up to 500,000 ft, an environment that can not be simulated effectively in a terrestrial sled.

#### Flight Testing

At these higher altitudes, atmospheric density variations, absence of ionosphere and the intensity of atmospheric illumination are markedly different from those at or near sea level. Also, vehicle velocities at these high altitudes are already beyond levels which can be obtained with existing sled technology, Lieberman said.

What means that flight testing "must be introduced much earlier into an evaluation program than is consistent with conventional inertial systems," he said.

Lieberman said that the God-

dard Evaluation Model which will be developed under USAF Missile Development Center sponsorship, appears to be ideally suited for the evaluation of stellar-inertial systems.

Stellar-inertial system requires that the star tracker be able to view the skyward stars through a window in the missile which is strong enough to withstand high temperatures, shock and vibration but which still offers extremely low distortion of the line of sight. Errors introduced by the window must be limited to a few seconds of arc, Lieberman said.

#### Single Window

This suggests the use of a single large flat window or one consisting of segmented flat sections to form a curved surface.

The latter allows the star tracker to view a larger volume of the celestial sphere, but may encounter blind spots due to structure.

There are two basically different techniques for combining stellar-inertial techniques for a guidance system, Lieberman pointed out. In one, the stabilized platform functions only as an accurate localized and smooth reference for making measurements of star altitude and azimuth in a manner similar to the traditional celestial navigation technique, except that measure-

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### **MHD Generator Produces 1,350-kw. Power**

Magnetically-driven (MHD) generator here has produced 1,350 kw. at over the highest rate reported and more than 100 times the power developed by earlier model, has been operated for more than 240 hr. by Aero-Electric Research Laboratory. Release channel is water cooled to withstand 1,600°F temperature of combustion gases produced by conventional propellant fuel reacted with potassium to make it an electrical conductor. Aero is building 20,000-kw., self-excited MHD generator under Defense Dept. contract.



# Hughes makes news in armament!

**Massive brainbore or major effort!**—today's air-to-surface tactical missions require new flexibility in armament. There are a greater variety of small, hard-to-see targets which must be attacked at short range from aircraft flying at low altitudes. Total time to fire is shorter.

The optimum weapon in this difficult environment is the high-rate-of-fire gun. It is extremely accurate, it reacts instantly. It has high lethality against a wide range of targets. Other advantages are low cost, logistic savings, over-all simplicity and reduced pilot exposure.

Gun Ordnance has been a major activity of the Hughes Tool Company—Aircraft Division for more than twenty years. This continuous gun development and production capability has culminated in advanced weapons—ideally suited for today's requirements.

Hughes gun ordnance capability includes the complete system—the gun, its installation, controls, gun sight and specialized ammunition. These systems are tailored to the individual missions of fixed wing aircraft, helicopters and ground vehicles.



**Hughes HIPEG—20mm gun pod**—Unique in the field of aerial armament stores, HIPEG is a complete, high performance gun system. The MK 11 gun fires 4000 rounds per minute—the highest firepower rate per pound of all 20mm guns. Fires up to 1000 targets and fires the most powerful 20mm round available. The HIPEG system contains the gun and 700 rounds of ammo in a representative enclosure. Developed for the U. S. Navy, it is now available for application on a wide range of fighter and attack aircraft as well as helicopters. Advantages of Hughes HIPEG. It can be removed for servicing and replaced by loaded pods for quick turn-around. Alternatively, the pod can be left off to allow the aircraft more visibility in two-gun missions. HIPEG provides three thousand per aircraft—greater aircraft utilization. An optional, Hughes HIPEG pod can be installed in multiples to provide greater firepower density or longer duration.



**Hughes ammunition developments** include 20mm armor piercing rounds specialized for use against ground targets as delivered from fixed wing aircraft, helicopters and ground vehicles. Also in development, a new 20mm retro round for the MK 11 gun against area targets.



**Hughes Heligun** has 4000 aimed-piercing rounds per minute at only 30 lbs. weight—seven times more firepower per gun than current weapons. Designed specifically for aircraft where turret guns are precluded, Hughes' new Heligun utilizes principles proven in its 20mm counterpart—the HIPEG. Fires the 7.62mm NATO round, the Heligun will provide dense firepower from helicopters, fixed wing aircraft or ground vehicles. Features include: Self gunner, instantaneous rate, low frontal area, positive protection from cockpit, kangaroo and double feed. Provenable or cartridge change, low velocity ammo fired from standard M13 links and only 190 lbs. average mass.

**Helicopter Armament Systems**—Hughes gun packages—designed for LOH use—can also be easily adapted for other helicopters. One package has a pair of M16 machine guns and offers: elevation control, quick installation, low drag, special gun sight. Alternatively, the new Hughes Heligun could replace existing guns to offer a fourfold increase in firepower and a five times reduction in drag. A third wing version would require the Heligun in an external pod. An interchangeable package contains the XM-75 grenade launcher.



4 Hughes HIPEG 20mm Pod with MK 11 Gun (4000 round-per-minute firepower) gives the Navy's A-1J mission effectiveness against small targets such as tanks and other ground vehicles.

Twenty years of experience applied to expansion of the state of the art... complete engineering laboratories, enclosed firing ranges and manufacturing facilities in one compact facility. These are the factors which have made Hughes unique as a producer of advanced armament for free world defense. Individuals with a need-to-know are invited to request further information. Please contact the Vice President-Marketing, HUGHES TOOL COMPANY, Aircraft Division, Culver City, California.



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### Laser-Lamps Developed

Laserlamps, in which laser action occurs in a discharge gas pumped through a porous ceramic coating, are product of Ima Electronics, Inc., Kensington, Pa. In operational models coated surfaces are electrically coated to full reflectivity except at one end where beam is emitted. The shaped lamp significantly lowers threshold at which laser action occurs. (See p. 1)

ments and comparisons are performed experimentally.

Second approach, which is better suited to bubble model problems, uses the star lights to correct for any initial misalignment of the platform pins as well as any drift that occurs during the boost phase. Lighting on one star provides a means for correcting your drift along an axis at right angles to the line of sight.

Using separate sightings on two stars supported by an angle approaching 90 deg. provides information to align the stable platform precisely about both axes as well as provide a heading reference.

Two separate star trackers can be used to obtain the two star sightings simultaneously. However, a single telescope can be used to sight both stars alternately with the guidance computer automatically making allowance for the different sighting times.

For an application such as the MMARM, where size and weight are extremely important, the single tracker is preferred.

In operation, when the missile has reached a suitable altitude, the computer (AFW No. 17, p. 115) will aim the tracker so that the star should be contained in its field of view if there is no error in the stabilized platform. Any deviation between the position predicted by the guidance computer and the actual star position generates a signal which is used to shift zero and platform zero into correct alignment.

The answer that the colored star field is the ultimate reference. However, presumably the computer will be designed to guard against misalignment, even when readings from a star tracker so that if the deviation between computer

### A RELIABLE ROAD TO RELIABILITY



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and aimed star position exceeds a reasonable amount is which the gyro might have drifted since the last sighting, the reading will be ignored.

#### Solid-State Tracker

Solid-state type star trackers, currently under development, are expected to offer the high response speed of a photoconductive vidicon with the sensitivity of the photoemissive photomultiplier tube in a unit smaller than either, Lehtinen said. The tracker will use a mosaic of photoconductive cells, made of materials such as cadmium sulfide or lead sulfide, which can be electrically scanned. The pattern of pulses obtained during the scan will indicate the position of the star within the field of view.

The tracker itself will be mounted as an integral part of the inertial reference cluster, with two degrees of freedom.

Use of stellar techniques on cosmic motion with control demands higher performance tolerances on the inertial portion of the system rather than laser, as might at first be assumed, Lehtinen said. The gyro system and its mechanical gimbals elegant to the gyro reference must be lighter, with less "hangoff angle" (inertia error) than is an all-inertial system. To minimize error due to backlash in the gimbals, direct drive-type torque motors are used both to position the inertial platform and the star tracker.

Measurement of platform and star tracker angles must be extremely accurate, which suggests the use of digital type potentiometers, particularly since the guidance computer is of a digital design.

The stabilization control outputs are used for flight control (autopilot) rather than as part of the inertial computations.

This raises the accuracy requirements somewhat, leaving it dependent not only on the needs of the flight control system.

#### Error Limits

All of these errors, including those introduced by the inertial reference, the missile must be limited to "a few seconds of arc." Lehtinen said. At the earth's surface, an angle of one second of arc corresponds to 100 ft. A total of 10 sec of arc accumulated error from all sources could result in a miss of 1,000 ft.

This figure of 1,000 ft is believed to be the CEP (circular error probable) goal for the mobile weapons range influence study.

Building and testing a stellar-inertial system to this degree of accuracy will demand a major upgrading of metrologies to assure that such design objectives, Lehtinen concluded.



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## GYRO A GENERATION AHEAD

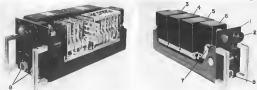
Swirling on a cushion of hydrogen gas instead of ball bearings, it out-survives its predecessor—the best until now—in times over 11 times torturous G forces without performance loss. Shugs off temperature change and magnetic field interference. Its slow rate is three times better than the next best. Its random drift is almost non-existent. Its time proven "ligament suspension" system guarantees reliability. It is

the sum of 40 freedom of design rebellious. It is efficiently compact—1/10th the volume of the best dependable instrument—and rugged. It has universal use from deep space to deep sea.

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**CONTROL RACKS** for pitch (left) and roll (right) channels of SP 727 autopilot, now in production and scheduled for use in at least 125 Boeing 727 short-to-medium range airplanes, have quantitative and qualitative self test capability, the advantages and selection for which are shown (1 and 2). Other items in view include pitch collector (3), vertical path amplifier (4), trim amplifier (5), pitch servo amplifier (6), rate gyro test amplifier (7) and system test set of correction (8).

## Sperry 727 Autopilot Stresses Reliability

By Russ Miller

Phoenix, Ariz.—Autopilot flight control systems designed and being produced here for the Boeing 727 short-to-medium range airplanes will reflect an unusually heavy emphasis on reliability as an effort to cut maintenance costs, boost pilot confidence and eventually make possible lower SFR requirements.

Autopilots, designated SP 727 and being manufactured by Sperry Phoenix Co., will incorporate a galeforce criterion made to give the airlines as all weather, low approach capability aimed at achieving a maximum altitude goal of about 125 ft. This is the same glide slope extension capability being added to operation of the Douglas DC-8 as an autopilot requirement for that aircraft (AW Dec. 11, p. 51).

While the SP 727 includes a number of technical advances, the stress is its development opens to entry on reliability from the component to the equipment level. The desire to simplify maintenance and minimize down time also figures prominently in the design philosophy. Thus, the autopilot is built, split on separate racks for yaw, pitch, roll and air data system equipment with provisions on each rack for go/no-go self tests.

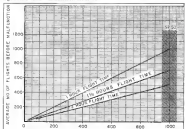
That emphasis contrasts somewhat with that of the company's SP 720 autopilot (AW Nov. 26, 1966, p. 76), which introduced many innovations to meet rigorous stabilization requirements posed by the emergence of commercial jet transport.

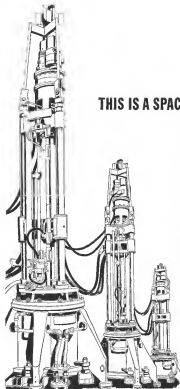
Now that the company has acquired its jet transport autopilot experience, the new autopilots do not appear too much as starting.

One notable innovation of the SP 720 had been the use of inertial stabilization, which substitutes acceleration



**AUTOPILOT CONTROL PANEL** for SP 727, shown, has single integrated yaw and pitch lock switches and designed primarily for ruggedness and reliability. Below, graph shows unusually high mean time between failures for the SP 727.





## THIS IS A SPACE AGE STEEL MILL

At first glance these units appear to be small missiles, secure on their launching pads, awaiting blast off. But they're furnaces, Space Age steel furnaces located at Latrobe Steel Company. ♦ Out of these furnaces come Vac Arc® steels, the special high strength, heat resistant alloys needed for jets, missiles, rockets and other Space Age products. Ingots are remelted . . . drop by drop . . . under a high vacuum to remove gases and impurities from the alloys before they are sent on to the rolling mills and forging presses. ♦ Latrobe Steel, currently in its 50th year of business, entered the Space Age in February, 1959, when the first arc was struck in the company's first vacuum furnace. In August, 1961, a second furnace was installed and in 1962, with the demand for the super alloys produced by Latrobe's furnaces so great, both a third and fourth unit were added. ♦ These new furnaces are just one step in the diversification and growth of Latrobe Steel, a company long recognized as the leader in quality tool and die steels.

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for rate gain and downward feedback for rate output correction.

Apparatus was not employed in the SP-10 for several reasons. Principal among them was the danger for cross-coupled packaging, with its tangled resistance and inductance in wiring. The Chubbuck approach lends itself to the use of rate gains which can be installed in each channel separately. Accelerometers would have to be located separately from the channel racks.

Besides the cited advantage of separate channel packaging, each flight unit of the autopilot can be engaged and operated independently, thus permitting split-arc operation, i.e., manual control in pitch and automatic in yaw.

SP-10 supplies dual yaw damper command through separate antennas to the aircraft's split autopilot. Doubly giving the aircraft a measure of fail-safe operation in the event of failure in one, there effectively is a redundant yaw channel. The system has potential for growth in additional dual channels on the other axis, a move toward increasing pilot confidence in going to lower maneuvers.

Yaw damper can be in operation throughout flight, including takeoff and landing. With a series actuator train to the manual controls, damper control action is not reflected at the rudder pedals, according to the company. The pilot will be able to maneuver the aircraft with his rudder control without experiencing an opposing force from the yaw damper.

### Other Features

Other technical features of the autopilot include:

- Improved omnirad direction of priorities.
- Adjustable subcarrier tone monitoring.
- Automatic lockout/VOR capture gainst pilot to set intercept angle.
- Better maneuverability through integrated turn and pitch controls.

Sperry has made several efforts to improve autopilot reliability. First, electrical components were selected with reliability and stability as major considerations. Only four types of transistors are used, and these are high-quality parts.

In one case a component type evolved from the extreme reliability improvement program for the guidance system of the Minuteman ICBM (AW Oct. 24, p. 57).

Whenever possible, solid-state components are selected, wire substituted for potentially more troublesome electro-mechanical parts.

Resistors are limited so they do not exceed 35% of their rated dissipation limit at 71°C. Capacitors are operated at half, or less, of the specified operating voltage rating, semiconductor components at less than 50% of manufactur-

ing minimum rated power dissipation for bias (AW Sept. 10).

Company says its computers indicate the reliability of individual dual yaw damper, will have a mean time between failure (MTBF) of 1,800 hr, about three times higher than field equipment.

An extensive reliability audit was conducted, under which all parts are evaluated to determine their ability to meet system requirements. Before approval, such part endurance measurements and life tests conducted by the parts vendor at Sperry. These individual items were checked, operating levels of each part measured with respect to its ratings and derating calculated on the basis of standard reliability data for the parts. This information was collected and incorporated in manufacturing drawings.

Average component cost used in the analysis, according to Sperry calculations, lies at MTBF greater than 100,000 hr, with the lowest figure, for the modulator-demodulator circuit (5,000 hr). Only one of every three cards will malfunction during the average 10-year operating period of an aircraft, the company says. System reliability is also pointed from summation of component failure rates.

Other factors reported to meet system reliability include a one-third reduction in the parts count of the system compared with other man-of-war autopilots, more extensive use of original feedback for long-term stability, reduction in the number of manual connections and relays, and more rugged mechanical construction. Following steps were taken to improve maintenance:

- Construction—Rack's containing equipment for each channel consist of a number of plug-in modules, each corresponding to a circuit function or second function. Within the modules, 1-in.-sq. aluminum circuit cards, on which components are mounted, can be rolled out and reinserted while the equipment is in place. This gives maintenance a chance to trouble-shoot equipment as an assigned task. Each module has a test potentiometer for controlling its tolerance. Further, the network actual circuit modules are printed circuitry are employed in another step to bypass potential trouble areas.
- Self tests—Go-no-go tests and self test indicators located on the face of each rack provide for self testing of installed equipment at a high resolution factor. Indicators are introduced to the autopilot wiring light, which will insure that the indicator is properly designed.

- Life tests—On the front of each channel is a line test set connector which permits a technician to make nearly 100 tests with the aid of a portable, semi-automatic long test analyzer in about 15 min and with a 95% confidence factor, according to Sperry.
- SP-10 has its own central air data sensor rack mounted that individual channels and completely independent of any central air data computer aboard the aircraft.

The sensor, which obtains altitude information, may be used for monitoring the glidepath reference.

Part of at least 125 production SP-10 autopilots has been delivered and is expected to be certified late next year.



### Photometers Detect Nuclear Debris

Optical photometers, developed by Graphicon Corp. of Ansonia, detect presence of nuclear debris from high-altitude nuclear explosions by observing scattering of sunlight from debris and identifying spectral lines of trace elements of debris elements.





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Designed for reliability and flexibility at temperatures ranging from -65° to 420° F., Storzline Super-T medium pressure Teflon hose and Super T-HP high pressure Teflon hose exceed the rigid requirements of MIL-H-25579 and MIL-H-8788 (ARP 604) respectively. The stainless steel braided cover hose and inner tube of Teflon has an operating range of 1500 PSI to 3000 PSI and is unaffected by all acids or synthetic base lubricants, oils, solvents, alcohols and coolants.

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<sup>a</sup>Values are  $\pm$  standard deviation.

445.2

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**FOR THE RECORD:** *Journal of Gerontology* is published 6 issues a year (March, May, July, September, November, and December). The journal is published by the American Geriatrics Society, 3515 Market Street, Philadelphia, PA 19104. The journal is published by the American Geriatrics Society, 3515 Market Street, Philadelphia, PA 19104. The journal is published by the American Geriatrics Society, 3515 Market Street, Philadelphia, PA 19104.

• **Microcircuit IFF Transponder Program**—Bureau of Naval Weapons is seeking companies with experience in both transceivers and IFF identification transponders to develop a unit weighing 15 lb or less with delivery required in 18 months. Qualified contractors must contact BuWeps by Nov 21.

► **Lunch-Phase Precision Trucks Planned**—Program to develop technology suitable for a precision ballistic missile trailer to be used during early lunch phase at altitudes of 150 ft to 60,000 ft is planned by Rome Air Development Center. Program objective calls for system to measure missile velocity to within 0.02 ft/sec second.

★**Orbital Attitude Sensing System Sought**—New-orbit study program to develop techniques for an earth-based system which can be used to measure accurately the attitude of spacecraft in orbital flight or returning from a lunar mission is planned by Rome Air Development Center. Objective is to provide means for evaluating accuracy of spacecraft's self-contained guidance and attitude sensors. Desired accuracy of measurement is to within 0.25 degree.

James Radohitye May Be Missing Asteroid—Not, though, to explain the long-sought (dis)connection between the planet Jupiter suggests that it may be the source of the magnetic field produced by solar induction on charged particles in the planet's atmosphere. The proposed theory, advanced by Dr. Louis Landau of Yeshiva University in New York City, was presented at the meeting of the American Astronomical Society in New York City. Landau, a senior research scientist at the Large Hadron Collider at CERN, says that the field of the asteroid is in a high energy state. A burst of solar induction effects the transfer of electrons to the surface of Jupiter's atmosphere, creating a field that is in a lower energy state and can be released as a burst of deuterium radiation, the theory holds. If proven correct, the theory would be a prediction of the existence of other planets in the field of other planets. Based on the principle that the New York University scientists call Jupiter's magnetic field has a strength of about 5 gauss, roughly 13 times the strength of the earth's

► **Transistor Unit Price Drop**—U.S. semiconductor manufacturers sold 155.8 million transistors during first eight months of this year, an increase of 31% over the same period last year, but dollar volume of \$193.8 million was down

about 5% for same period despite increased volume. Average per unit profit for first eight months was \$1.22, while average price during last month of the period was \$1.10.

► **Typhoon Data Tests Successful**—Data transmission tests using Typhoon communications satellite have demonstrated extremely low error rates. During one test from France to the United States, there was only one bit-error in a total transmission of nearly one billion bits at a rate of 875,000 bits per second.

► **Low-Noise Parametric Amplifier**—Passive amplifier using commercial quartz, gallium arsenide varactor diode, and a low-noise, high-Q resonator at a temperature of 42K, has exhibited a noise temperature of less than 30K, far lower than previously achieved for paramps and comparable to the performance obtained from active amplifiers. From Lucent Laboratories. The device operates at a signal frequency of 0.3 GHz (3000 MHz) using a pump operating at 15.5 GHz. Operation at signal frequencies up to 1.5 GHz and noise temperatures including an oscillator of about 20K appear feasible, according to Carl R. Rife, Lucent Laboratories, Red Bank, Md.

• New Cryogenic Thermometer—Gallium-arsenic diode, which exhibits an

quency, lower impedance, voltage characteristic at cryogenic temperatures is the most useful sensor yet developed for such use, according to Bell Telephone Laboratories. Zinc-diffused gallium arsenide diodes have a sensitivity of 14 mV/deg. K at room temperature and about 14 mV/deg. K at temperature of 1.9K, BTL reports. Resistances as within 0.01 degree can be obtained

• **New Detector Measures Sensitive Signature**—Equipment designed to make a "fingerprint" signature of a substance, possibly allowing the detection of explosives, is being developed by the Spectra-Physics Electronics Co., Sparks, Maryland. The company is a subsidiary of the Rockwell International Corp., Rockville, Maryland. The new detector is scheduled for delivery next summer. The development is part of Defense Department program to enhance and increase possible reliance on man-machine systems to detect and identify threats between various military equipment and riot equipment (AW Feb. 21, p. 55).

► **Atlas Guidance Gets New Memory**—Inertial guidance computer systems for Atlas models "B" and "F" are being replaced with new brainpower: magnetic core tape operating on redundant flux principle, which will permit rapid reprogramming of computer to handle change of target. New tape memory also will not lose stored data in event of power interruption or data read-out, according to American Bosch Airco Corp. which is supplying the units for its Atlas vertical launchers.



### New Rotorcyc Gyro Offers Decreased Drift

Improved Rotameter gas, Type 5TC-600, using noncontaminating bearing gases, has draft of only 0.04 deg./hr., an improvement of 25% over accuracy of earlier models (AW Feb. 17, 1955, p. 70). Non-lubricated gas operates over temperature range of -61F to 200F, reaches operating speed within 1 min. Manufacturer: Sauer Gases, Inc., Great Neck, N. Y.

# When you follow these welding instructions— you can perform wonders with USS® "T-1" Steels

USS "T-1" Steel, and "T-1" type A, are two of the most versatile steels ever developed. They combine very high yield strength (100,000 psi minimum), outstanding toughness, and ready weldability. Designers have taken advantage of this remarkable combination of properties to build stronger, lighter structures of all types, and to improve the performance of an immense array of heavy-duty equipment.

Achieving great strength and toughness in a steel is not an earthshaking event. But combining these properties with weldability is, as in the case of USS "T-1" and "T-1" type A Steels. It is this weldability that permits the designer to take full advantage of the strength of "T-1" Steels.

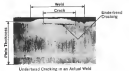
Being heat-treated construction alloy steels, USS "T-1" Steels require different welding techniques than other high strength steels. They are not difficult to weld, just different. Strong, reliable joints are obtained when the following three precautions are followed. We invite you to read them as a guide to realizing the full benefits of USS "T-1" Steels. They are detailed in a booklet which includes a Welding Heat-Input Calculator, and in our new welding-training film, "How to Weld USS "T-1" Steels" (see coupon).

## RULE 1—Use the proper electrodes

When manual arc welding "T-1" Steels, use only elec- trodes with low-hydrogen coatings. Or, use a welding method which is "low hydrogen" such as inert-gas shielded arc or submerged-arc welding.

Hydrogen is the number one enemy of sound welds in "T-1" Steels, as in all alloy steels, because it causes underbead cracking, resulting in unreliable joints.

To be sure you have selected the correct electrodes, remember that low hydrogen coatings are designated by the last two numbers of the electrode classification as 15, 16 or 18. None other, for example, E6015, E6016, and E1018 are satisfactory for welding USS "T-1" Steels.



Underbead Cracking in an Actual Weld

When you want to be positive that the finished weld will be as strong as the parent "T-1" Steel, use E1015, -16, or -18 rods.

Never use electrodes or electrode combinations containing vanadium to weld "T-1" Steels if the weld metal is to be stress relieved. Weld metal containing vanadium is likely to be made brittle by stress relief. Stress relief is only necessary with "T-1" Steels when re-

quired by codes and one or two other special cases.)

When welding "T-1" Steels to a lower strength steel, use low hydrogen rods of the strength level recommended for the lower strength steel.

Proper handling of electrodes is also important. When exposed to air, low hydrogen coatings will pick up moisture which is a rich source of hydrogen. Keep your electrodes dry. Use it a previous never to open more than 30 minutes' supply of rods at a time. Be sure way to keep rods dry is to keep them in a 250-300°F oven. If your rods have absorbed moisture, hot bake them in an oven according to the manufacturer's recommendation. One hour at 600°F is enough.

To use up Rule 1, for manual welding use low-hydrogen electrodes and keep them dry. For submerged-arc or inert gas shielding arc welding, use thoroughly dry fluxes and water-free shielding gases.

## RULE 2—Use correct welding heat

On most kinds of structural steels, high heat input results in superior welds. With "T-1" Steels, just the opposite is true. The best welds in "T-1" Steels depend on never getting over a certain maximum amount of heat. Less heat is used so the weld will cool quickly which, in "T-1" Steels, results in good, tough welds. Thus, you must closely control the amount of heat put into the weld.

For this reason, never preheat "T-1" Steels except in special cases. Preheating means more heat to get rid of and a longer cooling-off period, which can be harmful to welds on "T-1" Steels. The cases in which preheating is necessary are those in which the steel must be warmed to get rid of excessive moisture (a hydrogen source), where the piece is so restrained it doesn't have room to shrink after welding, or when thick pieces over 1" are being welded. Much of the time, however, preheating isn't necessary, and never preheat "T-1" Steels on touch alone.

The heat you put into a weld depends principally on amperage and the speed at which the arc moves along the joint. The higher the amperage, the more heat input. The slower the speed, the higher the heat input. Controlling heat input requires keeping amperage below certain settings and keeping the speed of arc travel above certain speeds.

There are two other important items to keep track of: steel thickness and temperature. Thicker sections can safely soak up more heat than thinner ones, so you can use more amps and slower speed. As for temperature, the section may have been heated up by preheating or by previous passes of the electrode. So if the section is already hot, you must cut down on amps or increase speed to avoid excessive heat input.

## Heat Input Calculator:

There's an easy way to determine the safe heat input for USS "T-1" Steels. The Heat Input Calculator which is provided with the book offered in the coupon. With it you can quickly find out what amount of heat will result from any given setup, and determine how much more you can safely put in. It is a



calculator "slide ruler" which tells, on the front scale, how much heat will be put into the joint if you know the amperage, voltage, and arc speed. On the back side of the calculator are tables showing the safe heat inputs for "T-1" Steels in several different thicknesses at different temperatures. This handy device is designed to help you get good welds every time. Heat input may also be calculated from the formula:

$$\text{Heat Input per Inch} = \frac{\text{Amperes} \times \text{Arc Voltage} \times 60}{\text{Speed, inches per min.}} \quad \text{Weld Speeds (Inches) Per inch of weld}$$

## RULE 3—Use recommended welding procedure

The straightforward stringer bead method is preferred for welding "T-1" Steels. Do not use the "fill weave" method. Weaving heats the metal more because the arc travel speed is slower and may cause excessive heat input. The proper method is to fill the groove with a succession of stringer beads.

Before a bead can be laid over an earlier bead, the flux, scale, or oxidation must be removed.

**Back gouging.** The preferred method is arc air gouging followed by clean up grinding. Do not use an oxygen-acetylene torch. There is danger of overheating which may cause an unsatisfactory joint.

**Speed.** Whether you control speed by machine or hand, control it closely. The Heat Input Calculator described above is your guide to the proper speed to reach maximum heat input.

**Filler welding.** Good fillet welding technique is more important with "T-1" Steels because the joints are usually required to withstand greater forces. Fillet welds in "T-1" Steels should be smooth, correctly contoured and well fused-in to the legs of the plates to be joined. The lapens of each weld should be made so that there is no root penetration but no undercutting. The weld shown on the left is ideal, the one on the right is to be avoided.



When thick pieces are joined, and when the weldment is to be stress relieved, fillet welds can be troublesome because of too cracking. There are several

ways to eliminate too cracking near fillet welds on "T-1" Steels. In the case of Tee or GJ joints where lower strength welds are often the rule, use low-hydrogen rods of the E60, E80, and E70 classes. Being lower in strength and more ductile, they are less likely to "pull cracks" at the toe of the fillet weld.

Air hammer peening of the weld can also be very helpful in preventing cracks, especially if the weld is to be stress relieved. Joints made even with the highest strength rods (E100, E130 and up) should be free from too cracks if peened. Sometimes it is necessary to peen each pass; at other times, peening only the top passes will prevent cracking. After peening, the fillets should be smoothly ground to fair the fillet into the legs of the joint.

Other methods that can prevent cracking include use of a soft wire pedestal, machine grooving the base of the upright piece, and laying down "butter" welds in the area. The first two methods allow the upright leg to "shrink down." The "butter" weld strengthens the "T-1" Steel in the area where a too crack may start. It is ground off prior to actual fillet welding and must be located so that the top passes of the fillet will be laid right over the strengthened zone.

## Free Welding Help

The space is limited in this book to a greater extent in our free book "How to Weld USS "T-1" and "T-1" type A Steels." It includes the Heat Input Calculator that helps the welder choose the proper welding settings. We'll gladly furnish enough free copies for your shop personnel. Also, you'll find our 15-minute, 16mm color motion picture on the same subject. Big help for you and your welders. The proper techniques for welding USS "T-1" Steels. Send the coupon. USS and "T-1" are registered trademarks.

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- 2. Also send the price list, color and sound movie of the 15mm motion picture. I understand there is no obligation.

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# Vestibular Screening of Astronauts Urged

By Carol Browder

Non-Reflexive means of detecting and testing out or curing space flight candidates with a marked susceptibility towards vestibular dysfunction during flight, as those experienced by Russian Cosmonaut Major Gherman Titov, are under urgent study in both the Soviet Union and the United States.

Lack of any feeling of motion as visual turbulence on the part of Major Andrian Nikolov and Lt Col Paul Fegredo, possibly subjects that the special payload physical training created for the two (AVC Oct. 3, p. 35) was helpful in reducing the discomfort, although some scientists apparently feel it may be largely a matter of individual resistance to the phenomenon.

## Planetary Measurements

Mariner V, Cold-Arm Earth-Course will participate in a new sounding rocket program aimed at seeking infrared and ultraviolet measurements of the planets Mars, Venus and Jupiter during their closest approach to Earth in the next several years.

Tell details of the program and cost division of responsibility for it between Ames and a future National Aeronautics and Space Administration facility, Goddard Space Flight Center, have not been settled. Launch vehicles, however, are expected to be either the Minotaur-40 or the Atlas 150 rocket capable of carrying 110 lb. payloads to distances of 150 and 200 mi., respectively.

Testbeds may also fit flights during peak intensity of the planet:

- Jupiter—October, 1981, and November, 1982.
- Mars—February, 1983, and March, 1983.
- Venus—May, 1984, and July, 1984.

Ames role in the NASA program will probably include the experiments which will be handled by the center's recently acquired Space Sciences Division, headed by Charles Sonett, who transferred from two months ago from NASA headquarters in Washington.

The rocket program may be launched after June, 1983, before the 1983-84 season. Further money is under consideration.

Ames hopes that data covered during the experiments will reveal a better picture of the frequency and symptoms of the planetary atmosphere.

Experts in this field among the approximately 180 delegates have for an international symposium on "Basic Environmental Problems of Man in Space" all agreed, however, with Dr. Arthur Gishpal of the U. S. Naval School of Aviation Medicine that "in space travel it is essential that we must be able to select men who will experience vestibular sickness."

A report presented at the conference by Soviet biophysicist, scientists M. D. Gerasimov and E. M. Yegorov, and such authors probably results from "disturbances in the physiological processes of the sensory mechanisms governing the perception of space." Their research, they said, has been confirmed largely by experimental investigations they have conducted concerning "the intensity of visual, vestibular and motor mechanisms and of the appearance of spatial disorientation."

Individual vestibular thresholds, they added, "vary within broad limits under the influence of certain visual conditions, posture and dynamic muscular tension."

## Tutor Hints

While they did not refer directly to the flight, Titov experienced during his 171 orbits in August, 1981, which he has attributed with the frequency of his head movements, head pain and nausea.

"The most frequent spatial disorientation and that accompanying vestibular reactions appear as a result of excitement of the vestibular apparatus when the subject is in a state of balance on an unstable support or when his own fall rate continuously varying objects."

"Static muscular tension and neural connections on a fixed object can adversely inhibit the appearance of these phenomena. The degree to which disorientation as the perception of space is, expressed depends on the individual production of the subject."

Scientific selection and training of astronaut candidates the paper added, "are the most effective countermeasures against these disorders."

This advice, which focused on new sources and areas of research in both the U. S. and USSR, was reinforced directly by Dr. Gishpal. He said the Soviet astronaut apparently suffered a "disturbance of the sensory mechanisms" which he described as "feeling unconsciously disoriented as though his body were in a permanent motion."

continued, after Titov had taken over manual control of the Vostok on the sixth and last day of the capsule through a series of left, right and complete turns, the astronaut suffered periods of dizziness and nausea.

"It could be a matter of adaptation," he said, to know whether Titov was, by nature, susceptible to vestibular sickness. He added that he "gives" him some Soviet astronauts have said that this applies to the crew.

A member of the Russian delegation said it was his understanding that U. S. astronaut Major Lt Col John Glenn, had "fainted" during his three-orbit flight and added "how long did his vestibular sickness last and what were the symptoms?"

## Glenn Faint Denied

Gratified denied any such knowledge on the subject, Dr. S. C. Wilcox, of the National Aeronautics and Space Administration's Human Spaceflight Center, and from the fact that he also was unaware of any such incident.

Gratified, however, that Glenn had suffered no feelings of sickness during flight but that after landing he did experience "some stomach movement" during his stay in the satellite before return and afterwards during the recovery process.

While he didn't bother him very much, damp passed when Glenn arrived on the main ship, dock of an aircraft carrier, Goddard said.

## Ranger Schedule

Ranger 6, first of at least nine Rangers have spacecraft will carry several television periods consisting of a package of on video cameras for observing high-resolution photographs of the lunar surface before the spacecraft reaches the moon, will be launched from Cape Canaveral, probably between Jan. 15 and 16.

Ranger 7, another spacecraft in this series, will follow in March, Ranger 8 in the spring—possibly in May—and Ranger 9 in late summer (AVC Oct. 28, p. 30).

Ranger 10, the last of the nine spacecraft, possibly will be added to the series, is scheduled for a launch late next year, probably in November. Four remaining shots in this experimental series, Ranger 11 through 14, will be launched on a staggered schedule in 1984, concluding by the end of September.

While added that Glenn "never demonstrated fainting or susceptibility" during flight and had, in fact, "not felt" his stomach. The, he said, coincided in the point where Glenn experienced no feeling of nausea.

Reaching susceptibility to vestibular sickness, poses a problem, Gratified added, since it is impossible to simulate weightlessness for long periods under terrestrial conditions. He added, however, that "there is great evidence that susceptibility to symptoms in one type of gravitational/inertial force environment has predictive value for exposure to another type."

In a closed training, he said, that "all motion sickness is vestibular sickness, but some vestibular sickness is not motion sickness."

Studies conducted thus far by the Naval School of Aviation Medicine on motion-induced conditions began with the comparative comparisons between normal and deaf subjects. The motion tests were conducted primarily as a "doubtful" zone, a counter-attack was seen located in Toronto, Canada, and showed aircraft in flight.

These experiments, "though far from complete indicate that persons with labyrinthine defects are relatively susceptible to motion sickness and to some extent to motion sickness, which may cause symptoms in healthy subjects."

## Test Prior Resistance

He also noted that the plain can seem to have a greater resistance than normal to vestibular disturbances and suggested that this may indicate an ability to adapt one's system to a particular environment, said, and now, this point has not been a criterion in the plane's selection.

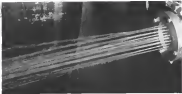
He warned, however, that adaptation may be highly selective in nature. In the tests, he found that a subject could be screened to have a high level of resistance to motion sickness, but not to motion sickness, which may indicate an ability to adapt one's system to a particular environment, said, and now, this point has not been a criterion in the plane's selection.

Gratified concluded that so long as astronauts are selected for flight, they will have a large number of symptoms, "but almost automatically eliminate those with more than a small number of symptoms."

A bigger problem, he added, will come as the selection of astronauts with little or no previous flight experience to participate in multiple flights.

Dr. R. Lovelace II of the Lovelace Foundation for Medical Education and Research, who said he expects that a selection of the Mercury astronauts and scientists will need to undergo a minimum of one year's training before flight, he added.

Prior to their examination and selection, these data will not have been



## Standard Injection, Acrotion Throttling Composed

Conventional payload injection (api) is composed with Atlas Technology Corp.'s new thrusting system (bottom), which the company has tested in about 600 test flights (AVC Nov. 5 p. 27). UTC developed a design to reduce thrust-by-increasing its thrust gas into multiple to some 1000 psi upstream to 150 of reducing velocity and still maintain combustion stability. Acrotion throttling system has been selected for Apollo lunar excursion vehicles and space station uses.

exposed to the stresses of flight is that reaction in such systems will be no longer and, thus, the selection process will be more difficult. The Centaur program will be most helpful in the final selection, modification and testing of systems as they can go along in orbit flights with an experienced astronaut."

Report delivered by Dan Thielges, former head of the U. S. Air Force's human factors research program, and now a research consultant at Washington, and co-authored by Dr. Allen Alder, of the University of California's Space Biology Laboratory, suggested that "in a critical manner of the effects of vestibular stimulation, the monitoring of the brain's electrical patterns through scalp recordings may prove very important."

The wide variation in individual susceptibility to vestibular stimulation, the report added, plus the "disturbing" effects as the highly susceptible would appear to make further application of EEG (electroencephalogram) evaluation of the subject's susceptibility to motion sickness, and adaptation should be necessary.

To carry out these and other measurements in a space environment, Thielges and Alder have developed a series of lightweight, battery-powered devices capable of being fitted into a standard space helmet. In the design of the equipment, the report said, particular attention was given towards development of a recording technique that would represent an essentially "non-invasive" approach to the problem. It added.

"The transferring of brain electrical activity from the scalp directly, if possible, would avoid direct attachment to the scalp by adhesive electrodes, and, in principle, should avoid the problems of the scalp by skin air in acute electrode. It should be compatible with any normal haircut, and adaptation should be necessary."

Studies made as a number of subjects by the two scientists also indicate that prolonged periods of weightlessness may produce a "major reduction in sensory input" from sensory and joint receptor mechanisms in prolonged weightlessness but that "approximately normal sensation will occur" in the astronaut's



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seditory, visual and extraneous receptor mechanisms. Further effects related to the reduction of sensory input, the report said, "may develop in the expected to occur in space with under exceptional circumstances."

One such consequence might be prolonged absence of light and the necessity of resting in the environment at total darkness for a prolonged period of time.

To test the possible effects of this condition, Packinger and Allen used a sense of an alien and knowledge of sensory input in total darkness and white (random) noise from shock at both for periods exceeding three years in some instances.

#### Monkey Experiments

These animals, the report noted, "appear to sleep very little and display in most cases a restless activity, with constant pulling and pushing at objects in the environment. They exhibit hostile and disturbed behavior patterns, with attacking of their own hands, chewing of their own limbs and destructive movements of limbs not actively employed in concerned activities, such as twisting. Eating food such as a banana may be accompanied by violent head shaking from side to side, with growling noises resembling a dog."

These and other tests also indicate that full attention may occur, with the test animals paying and clearing at various objects. The report said that "whether the degree of sensory reduction in the space environment, even if prolonged, ever reaches a threshold level, remains to be seen."

#### Accelerated Research

Dr. Lovelace, in his report, made a plea for "an accelerated research program on an international basis" to establish realistic environmental simulation to test the effect of angle as well as combined stresses that occur in the space environment.

He said that these thresholds of performance degradation in man should come under study:

- Degradation from low performance.
- Coordination with reversible tissue damage.
- Short and long-term degradation with reversible tissue damage.

Lovelace also suggested the establishment of an International Scientific Advisory Council supervising the various clinical and acoustic disciplines for "disseminating existing knowledge and examining the progress and future requirements of all research concerned in coordination and selection of instruments, size of payload with dynamic or static weight in space, the effect of angle and combined stresses in space, with particular respect to performance degradation of the crew."

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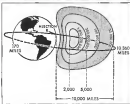
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## Explorer Studies Earth's Artificial Radiation Belts

At left technicians check on Explorer 35 Ranger-Proton Satellite (500) which was successfully launched from Cape Canaveral, Fla., Oct. 27. The satellite was launched by a three-stage Thor-Delta vehicle. Principal experiments aboard the 95-lb. satellite were on electron energy distribution devices, electron and proton counterstreamer detectors, electron angular distribution detectors, and electron directional detectors. The satellite is transmitting world data through its high-gain rate approved to be effective affecting some of the satellite's functions (AW Nov. 5, p. 41). Bottom photo shows SIB photographed as a simulated space environment.



Mission of Explorer 35 is to study the artificial radiation belt created by high-altitude nuclear test over the Pacific last July 9. Satellite perigee is 1457 mi., apogee 10,768 mi. Figures at right are those NASA projected.



## University Space Support Role Expands

By Warren C. Wetmore

Chicago—Dependence on universities to provide manpower and fundamental research for the U. S. space program is shaping a new relationship between the government and colleges according to Dr. George W. Beadle, president of the University of Chicago.

Beadle recently acted as spokesman for the university viewpoint at the first National Universities and Space Administration-University Conference on the Sciences and Technology of Space Exploration held (AW Nov. 12, p. 35).

Purpose of the conference, was to inform college administrators and faculty of NASA's need for higher caliber research and better trained students to meet national goals in the exploration of space. NASA listed about 600 gaps in research and science graduates but has, and will increase this number next year to 800 as its expanding needs.

Beadle praised NASA's efforts and policies in its programs with the universities, but referred to the conference as academic ranks about the value of some aspects of the space program, particularly Project Apollo.

"Speaking of leading that race as the atom," he said, "there are more people, academic institutions who wonder, should we do this, or wouldn't it be better to do something else?" I think this is certainly a debatable point.

### Research Support

Role of the government in supporting basic research and providing laboratory facilities is increasingly growing, Beadle said. Only the government can afford the large sums of money required for expensive facilities and equipment, he added.

He also pointed out that economists, social scientists and lawyers must of their basic academic institutions, will be needed to resolve perplexed problems arising from the space program.

Beadle stressed the necessity of developing more effective lines of communication between the three corners of the scientific triangle—government, industry and academic institutions, as well as better means of collaboration and communication within the academic community.

The latter, he said, is being accomplished by the 12 colleges and universities in the Associated Midwest Universities, an organization created to utilize the various research facilities of the Argonne National Laboratories in Illinois. More cooperative laboratories of that sort are necessary, since no single

university could afford the facilities that would be possible by all in a jointly-operated installation, Beadle said.

While commentary from delegates to the NASA program of university support was largely favorable, there was some reservation. One delegate felt that in making these grants the government would inadvertently erode a nucleus of the universities' traditional freedom. He also complained that the emphasis on space is disproportionate, and that the field is getting the best university graduates in science and engineering, in the eventual detriment of other non-space fields.

Another delegate feared that, with huge amounts of funds being made available, the quality of research might suffer and that some unworkable projects would be funded due to the increased work load of NASA's internal research. Research contracts as, becoming an academic status symbol, he said, and university administrators are often more concerned with whether the research is sponsored, rather than with the scientific value of the investigation.

In another session, the delegates were told that space exploration will come a culmination of the various scientific disciplines and a firm view from exploration. Dr. Robert Jastrow, direc-

tor of NASA's Institute for Space Studies in New York, said that because of its fundamental nature, physics provides the most serious of students who go into space science, but that there could be more emphasis on such subjects as anthropology for physics majors and on atmospheric physics in the earth sciences.

It would be a mistake to create independent space science departments, he said, since students should first learn the basic, traditional concepts.

### Interdepartmental Commitments

The solution, Jastrow said, can be found in the creation of interdisciplinary committees, whose function would be to advise students and plan courses of study for those interested in space sciences.

Courses in space physics, for example, could be developed along traditional lines but with strong emphasis on non-deceptive astronomy. Such programs, he added, would provide a broad base for future developments.

Dr. Thomas L. S. Smith, director of NASA's Office of Grants and Research Contracts, said that in addition to projects, research—the total dollar value of which has doubled each year since NASA was organized in 1958 and probably will more than double in fiscal



### Satellite Communications Relay Antenna Developed

Lightweight apert and photomultiplier-tube high gain antenna array has been developed by Space-General Corp. for use on satellites for relaying communications between space craft to sub-orbital flights and earth stations. AW has two sets of three orthogonal antennas coupled with amplifiers powered enough to receive intensity of signals from space craft and relay them to earth. Antenna system would automatically point toward transmitting source while receiving signals, company says.



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## Ryan's spectrum of capabilities

These notable breakthroughs by Ryan scientist-engineer teams, demonstrate proven capability to create the necessary technology and to manage every phase of new, complex systems.

- Design, build and fly the world's first jet VTOL airplane. Then apply over three million man-hours of VTOL experience to creating such modern aircraft as the Army's YF-16 fighter aircraft.
- Take a concept like the Rogallo wing and develop a successful real test vehicle with broad applications—the Ryan Flex Wing.
- Pioneer the CW Doppler principle into world leadership in the production of electronic navigation systems for all types of aircraft now flying or projected.
- Develop complete jet target systems like the famed Ryan Firebee—most widely used target jet in the free world.
- Design and fabricate radar altimeters, precision antennas and space structures for such advanced space vehicles as Mariner II, Saturn, Surveyor.

From advanced astronautics to the fabrication of space age metals, Ryan is prepared to assist government and industry in early studies, design, development, production, and the field support of complete operational systems and equipment.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

**RYAN**  
AERONAUTICAL COMPANY

# ADVANCED THIN FILM MICROCIRCUITRY PROVIDES NEW DIMENSIONS FOR LSI INSTRUMENT DIVISION PRODUCTS



Thin-Film Microcircuitry



Miniaturized, integrated thin-film microcircuitry provides enhanced performance and reliability for aerospace electronic systems.

**The Task:** To provide the aerospace industry highly reliable, miniatured electronic systems and components utilizing economic, mass produced thin film microcircuitry.

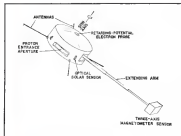
**The Solution:** A new, semi-automatic high vacuum deposition system developed by LSI for volume production of thin film microcircuitry, now in full scale operation at the Instrument Division. This highly precise production technique, coupled with a unique ability for extreme accuracy in the layout of electronic circuits, offers great flexibility in the design of Instrument Division electronic systems since it combines significant miniaturization with unusual performance and reliability characteristics. Instrument Division customers are being provided products with the many benefits which this unique microcircuitry production process affords, including substantial size and weight reduction, as well as greatly increased performance, reliability and extreme environmental characteristics. This is a portion of the LSI Instrument Division's continuing program to provide the next generation of aerospace guidance and control equipment, as fast or faster than requirements become known.



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## USAF to Study Solar Winds

Experiment to study structure of solar winds and earth's magnetic field and determine detection of field by ion plasma will be launched on Air Force/Chesapeake Bay Space. Payload developed in USAF Space Weapon Center, N. M., will have ion probeheads to earth ion line, with optical solar sensor triggering of measurements and identity transmission. Complete laboratory time is expected every 1 of a revolution of experiment.

FOCS-NASA has selected recently the University Program to "study significantly the university participation in space science and technology and complement the expanded research activity of NASA."

University program includes the following:

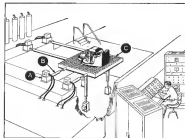
- **Training grants** (AW July 2, p. 157), which will increase the future supply of professional technical personnel required in space-related science and technology.
- **Facilities grants** (AW Oct. 1, p. 27) to provide adequate facilities necessary for space research.
- **Special-purpose research grants** to strengthen academic research and permit them to increase support of NASA programs through encouragement of creative investigations in scientific disciplines, and to develop new capabilities and pursue consideration of activities and stimulation of funding.

## Manpower Shortage

Prime NASA concern is the impending shortage of highly-trained technical manpower, Small stated, and more money of these personnel will be engaged in space-related efforts, NASA wants to accelerate the production of doctoral degrees in both science and engineering fields.

Under this phase of the program, the university receives a training grant and then selects the trainee. The awards,

which may be for three years, cover an amount of \$5,000. Recipients of the grants should be U. S. citizens, and their qualifications are reviewed annually by the university, which NASA



## Six-Degree-of-Motion Astronaut Trainer

MP Electronics will build six-degree-of-motion astronaut training simulator at Wright Patterson AFB, Ohio, under USAF NASA contract. Components shown in drawing include hydraulic chocks (A) which actuate pushrods and assembly joints (B) to obtain maximum test platform (C). Simulator will accommodate 2,000 lb. load and achieve velocities up to 30 gps and pitch as high as 20.

reimburse for any reasonable expense incurred in training grantee.

Initial program, started in September last year, p. 117), involved 10 students at each of 18 universities. A job-related increase in the program is planned for the next academic year, with the addition of an additional \$300 to \$750 production students, Small told the delegates.

## Laboratory Shortage

In carrying out its activities, NASA saw the need for alleviating the acute shortage of laboratory space in the universities.

Grants will be made to academic institutions and to non-profit research organizations to purchase or build additional facilities for research in space-related science and engineering.

Dollar values of these facilities grants will be determined by NASA, and may be as much as the full cost of the proposed structure. The title is a laboratory or other research facility will be vested in the government, unless the NASA administrator determines that the national space program will be served best by transferring the title to the grantee.

Small said that the first grants under this program were awarded in September to five universities, and that the facilities were based on the university.

Special-purpose grants—designed to help the universities help themselves—will be made to increase competence





A report on economical shorter-haul power



Prototype JT8D being ground tested at Boeing with actual order and out to be used in the three engine Boeing 727. Lightweight JT8D develops 14,000 pounds thrust.



JT8D met all SFC gas turbine tests at the Wilcoxon Turbine Engine Test Facility. JT8D ran 400 hours at 25,000 to 35,000 feet at 0.8 Mach, and various temperature conditions.

## JT8D begins FAA certification tests

Pratt & Whitney Aircraft's new JT8D turbofan has begun Federal Aviation Agency tests that will lead to certification of the engine for commercial airline operation. Significant portions of these tests are already completed.

The tests should be completed early in 1983, when Boeing's 727 short-/medium-range jet transport begins flying. The 727 will be powered by three of these 14,000-pound turbofans.

JT8D development testing began in 1968. Since then, the engine has:

- Completed more than 4,700 hours testing, including 1,000 hours of endurance in accordance with the FAA's 150-hour test schedule.
- Completed six company 150-hour endurance tests.
- Logged more than 60 hours in flying test beds.
- Exceeded or bettered all specifications in altitude thrust specific fuel consumption.

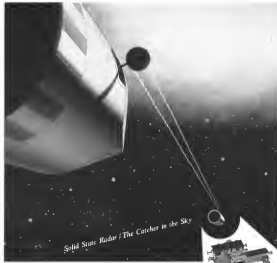
Seven JT8D's have already been delivered. These advanced powerplants will help the 727 operate from 5,000-foot runways and economically fly 70 to 114 passengers over routes of 150 to 1,500 miles.

**Pratt &  
Whitney  
Aircraft**



DIVISION OF UNITED BRIDGES CORP.

1001 HARTFORD, CONN.



A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man understand and track vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight by sharing its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force ARPA. And STL continues Systems Management for the

Air Force's Atlas, Titan and Minuteman programs. These activities ensure immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwave • Inertial Guidance • Avionic Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Patton, Department A14 One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.



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a subsidiary of Thompson Rome-Woodbridge Inc.

Los Angeles • Vandenberg AFB • Hatter AFB, San Bernardino • Cape Canaveral • Washington D.C. • Dayton • Huntsville • Dayton

in areas where research activity is needed.

Small added that these grants may be used to conduct related minor projects whose support comes from varied sources, thus lessening the air part of funding fluctuations.

#### Special Funding

Special funding method will be used for university program grants to stabilize programs extending over several years. The method involves a long funding—extension in total three-year grant, which provides 100% funding for the desired level of effort during the first year, two-thirds during the second and one-third during the third year of the program.

This agency is set aside and then paid according to a pre-arranged schedule.

The project is reviewed annually and if NASA decides to continue its support and supporting funds are appropriated by Congress, the grant will be supplemented each year to bring it up to the agreed level of effort for that year.

Thus, if support is terminated for any reason, the university will have funds coming for another two years and will be able to discharge its obligations if any have accrued in connection with the program.

#### NASA Guidelines

NASA's guidelines for this program represent the most liberal approach ever made by the government in working with the universities to accomplish a specific mission. Small noted "As long as universities demonstrate that they are able to carry on these activities at a creative and responsible manner," he said, "these guidelines will remain broad."

Dr. Hugh L. Dryden, NASA deputy administrator, emphasized the agency's desire to work within the existing framework of the universities in the course of accelerating study and research in

#### Training Grants

Washington-Ten universities have received training grants for the support of low doctoral candidates in space science and engineering.

Grants, which are a part of NASA's supplementary Supporting University Program, were awarded to Rochester Polytechnic Institute, University of Maryland, Georgia Institute of Technology, University of Michigan, University of Chicago, University of Minnesota, State University of Iowa, Texas Agricultural and Mechanical College, Rice University and University of California at Los Angeles.

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**CEC's New Wide-Band Magnetic Tape Recorder/Reproducer Systems** give you twice the capability of information storage as conventional machines. Bandwidth: 100 cycles to 200kc, direct—5 to 20 kc, FM 6 speeds. Solid state throughout for low power consumption and weight. Type VR-3000 is the portable model and Type VR-2000 is ideal for data gathering in lab, van, shipboard and blackboard environments. For complete information and specifications call your nearby CEC office or write for Bulletin CEC 2800-X18 and 2800-X15.



**CEC**

Data Recorders Division

**CONSOLIDATED ELECTRODYNAMICS**  
PASADENA, CALIFORNIA • A SUBSIDIARY OF WELLS & HOWELL



## APOLLO SUIT

The first integrated space-suit assembly will be developed by Hamilton Standard for Project Apollo, under contract to NASA. They will provide eondent and mobility for astronauts outside the suit in deep space and on lunar exploratory missions. Hamilton Standard, as prime contractor, will manage the program, and design and build life support packs. The packs must supply oxygen and pressurization and control temperature, humidity and contaminants. Subcontractor for the suits will be International Latex Corporation.

The space-suit project, an important portion of Hamilton Standard's life support program, applies diversified experience in hydraulics, pneumatics, mechanics, electronics, and packaging. Hamilton Standard blends and develops these basic technologies to achieve an integrated systems approach to life support equipment.

**Hamilton Standard** DIVISION OF UNITED AEROCRAFT CORPORATION  
WINDSOR LOCKS, CONNECTICUT

U  
A



### Radiation Detector

Device developed by General Electric is designed for monitoring doses from background to detect radiation levels in nuclear blast centers. Recording level of reasonable doses at a period of approximately 30 days.

space technology. NASA does not want to create independent contractual activity which tends to divert the scientific profession from the forefront in the performance of his research.

"It has been estimated that by 1975 as many as one-fourth of the nation's trained scientific and engineering manpower will be engaged in space activities," Dwyer said. "The consequence alone is the problem of this talent and, like the farmer who has a responsibility of preparing for the future the trees which he harvests, NASA, as a part of man's future, has an obligation to care a few share of the load of replacing the resources consumed."

### Program Goal

Unmanned program, he said, has as a goal the support of about 4,000 dual dual candidates at 150 generators, and will yield 1,000 new F&Ds in space-related fields annually.

In October and that \$16 million of Fiscal 1962 NASA funds was given to academic institutions, of which \$25 million was in support of project research. Special-purpose research grants totaled about \$13.5 million. Facilities grants approximately \$6.5 million and training grants \$2 million. Estimates for Fiscal 1963 show an increase in the total research program, including project research, to about \$45 million.

Not all NASA contractors are in full support of the Sarbanes University Program. One high official privately voiced criticism of NASA's dual involvement in the program, stating that it is beyond the extended scope of NASA's mission of research and space flight activities.

The official said that the program could be streamlined better by the National Science Foundation, in keeping with its traditional role in support of academic research and graduate studies in research and engineering.

## Subcommittee Urges Strong Single Manager for New Advent Program

Washington—House Space Sciences Subcommittee has decried the waste and inefficiency in the joint management of the Advent communication satellite project and recommended the appointment of "a strong single manager" at Dept. of Defense level to keep the same thing from happening in the renewed program (AVF June 25, p. 32).

The subcommittee, in a report and report, said there was "little or no evidence of a spirit of cooperation between the Army and the Air Force in the Advent program." It said this is one reason "the program has very little to show" for the \$270 million it has spent as the effort. The report also said the director of Defense Research and Engineering (DDR&E) "ought have improved the Advent project immediately."

DDR&E was in overall charge of Advent when the Army was project manager, and is playing the same role now that the Air Force is the program manager. The subcommittee said it agreed with Brig. Gen. Joseph W. Johnson, Army project manager for Advent, who said the only way to do the job efficiently was through a strong manager with authority in all seven service areas.

The subcommittee supports the idea that it is impossible for two or more military services, or civilian agencies of the government, to work effectively and harmoniously on a particular development program. Clearly, a single manager endowed with both responsibility and authority is the most effective organization.

agreement organization, and that was lacking in Project Advent," the report said.

As an example of unnecessary delay which proved expensive to the program, the subcommittee cited the case of the Air Force cancelling its contract with Space Technology Laboratories as soon as the Army signed a contract with STL for the same type of technical guidance on Advent. USAF signed a new contract with the Aerospace Corp. for the work formerly performed by STL.

The subcommittee said the two services should have been able to agree on a single administrator, going.

The subcommittee also criticized the Air Force for refusing to let the Army stage its representation to the General Electric plant where the Advent satellite is being fabricated. The Air Force restriction, the subcommittee said, was a curious restriction for a participant in such a venture to place upon the agency which has back a varied overall management responsibility for the program.

The renewed program calls for launching 24 to 30 medium-orbit satellites, rather than the high-orbit geostationary satellites originally planned. The subcommittee cited the uncertainty of past cost estimates in Advent, and said it wanted to be assured that the newly renewed program "will be justified by the anticipated volume of military traffic and the specific needs of the military which cannot be adequately satisfied by alternative means."



### X-20 Nose Cap Materials Tested

Methods for fitting X-20 DynaSoil epoxy glue onto dry sanding high temperature tests on speed ring which can generate more than 4,000° over heat. Ring was built by Eng-Tech-Vought, within 30 welding torches having oxygen-propyne combustion. Zirconium dioxide spalls heat over spectrum in moderate density conditions.

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# UTC DEVELOPMENT CONTROLS THRUST OVER 1-TO-100 RANGE!

**STATE-OF-THE-ART ADVANCEMENT**—United Technology Corporation takes pride in announcing what may be one of the most important liquid rocket propulsion technology developments in this decade: variable thrust control over a range of 1-to-100. This company-sponsored development can provide up per stage liquid rocket motors with the levels of operational flexibility demanded for rendezvous, docking, and soft landing missions. UTC's new aerated thrust motor will permit a spacecraft to hover, translate, and re-orientate with a maximum degree of precision and control.

**COMBUSTION STABILITY**—UTC's variable thrust control system is a model of simplicity. An inert gas is injected into the propellant just before it enters the thrust chamber. A series of linked valves controls the propellant/gas mixture, permitting the effective density of the propellant to be varied over a wide range and provide any desired thrust level. Gas may be taken from the same source used to pressurize propellant flow. This new technique provides UTC's rocket motors with a degree of combustion stability never before accomplished by any thrust control system.

**IMPROVED MOTOR PERFORMANCE**—Hot firing tests of this UTC propulsion device indicate that motor efficiency is improved to 95% of theoretical l.p.p. Motor life is prolonged, since the aeration technique prevents unbalanced combustion, channeling, and erosion of thrust chamber walls. The possibility of explosion during motor firing is almost completely eliminated. The safety, reliability, and flexibility of UTC's new system of variable thrust control by aeration make it a strong candidate for use in lunar excursion missions, orbital revision, or module-to-mother-ship docking.



**United Technology Corporation**

Box 358, Escondido, California

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**U  
A**



## Mercury Landing System

Full-scale model of Mercury spacecraft designed for one-day missions, descends and parachutes after leaving from C-119 transport to qualification tests of spacecraft landing system developed by Northrop Ventura. Ringed shaft will also be used with standard landing gear system.

## NASA Contracts

National Aeronautics and Space Administration recently awarded the following contracts and research grants:

### MANEUVERABLE FLIGHT CENTER, RESEARCH & ANALYSIS

Arnold General Corp., Denver, Colo.—\$1,000 for flight center, analysis program for test program.

Chrysler Corp., Detroit, Mich.—\$1,000 for flight center program, research, data processing system.

Electronic Systems & Controls, Inc., Bedford, Mass.—\$1,000 for flight center program, research, data processing system.

General Electric Corp., Springfield, Mass.—\$1,000 for flight center program, research, data processing system.

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# Throughout the world—



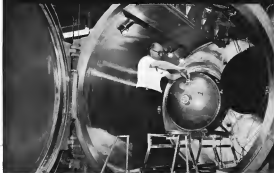
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The Goddard 5 by 5 (5 ft. in diameter and 5 ft. long) horizontal test chamber is one of the key elements in the reliability testing program at NASA's Goddard Space Flight Center, Greenbelt, Maryland.

Godard's "B by B" will continue to serve as the incubator for the Space Flight Center's highly successful reliability testing programs until the consensus test and evaluation laboratories under construction go into service early in 1965. Major space test chambers of the facility, which is designed to test the most advanced standards for spacecraft check-out, are two 36 ft. diameter, 80 ft. high thermostatic environmental simulation chambers. Stokes was selected as a prime contractor to NASA for complete vacuum and cryogenic systems for these large chambers.

We welcome your inquiries regarding our capabilities and facilities for designing, fabricating, and erecting simulation facilities with in advance of the state-of-the-art, in any portion of a simulation project requiring high-vacuum and cryogenic systems. Space Systems Department, P. O. Sholes Corporation, 3330 Teller Road, Philadelphia 20, Pa.

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**STOKES**

Boeing Co.'s Vertol Division has been awarded an \$18,475,121 Navy follow-on contract for production of additional CH-46A Sea Knight assault transport helicopters (AW Oct. 22, p. 30) for the Marine Corps.

D. B. Milliken Co., Azusa, Calif., has received a contract from Space General Corp., El Monte, Calif., to build four *Altair* spacecraft systems for use on a lunar deployment and recovery operation of National Aeronautics and Space Administration's inflatable microcassette payloads (IMP). An Aeroshell 150 rocket is scheduled to boost the package shortly next year (AW Oct. 8, p. 32).

Boff Helicopter Co. has been awarded a \$75 million Army contract for production of UH-1B and UH-1D Huey helicopters. Contract is annual funding for Army's Fixed 1963 orders, which is expected to total \$75 million for 279 UH-1Bs and 121 UH-1Ds.

Rehr Corp. has received follow-on contracts totaling \$15 million from Boeing Co. for production of jet engine pods, struts and stabilizers for Airbus A320-233s and A321s.

Falck Ltd. Station Corp. will continue development of its AN-1105D-50 in the service. This will include a \$100 million contract from Army's Electronics Command. Contract will cover development of the jet engine, now in preliminary flight test stage, forward fuel light demonstration. The 1105D-50 which carries a variety of electronic warning systems, is also being launched from a tanker bed.

**Letts Industries' Aero Service Corp.**, Philadelphia, Pa. will build three experimental, human-target models for F-103D flight simulations under a \$1,466,090 Air Force contract. Units will be constructed to male and female and positioned to reflect light in the same proportions as actual human-target objectives of radar cones.

Trent Instruments, Inc.'s Mirrors and Controls Division has won a \$160,000 contract from Air Force's Aeronautical Systems Division to evaluate, combine techniques for producing refractive, total alloy beds and to define optimum manufacturing procedures.

Space-General Corp., Ft. Worth, will readily compare-developing guidance subsystems under a \$104,000 contract for NAVI's Project Vector Modification is aimed at design, development and test of a system to stabilize and control launch vehicle upper stage-payload combinations.

www.elsevier.com

TO: J.M.H.

Doc't 41-A

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Patented March 2, 1937. No. 2,052,123. Chrysler Motor Corp. 1408 and 1409 West Standard, Chicago, Ill. 60604. For colored data see the Chrysler 1938 Series with the Forward Company, Cherry Hill Division, Box 2637 N. Santa Ana, California.

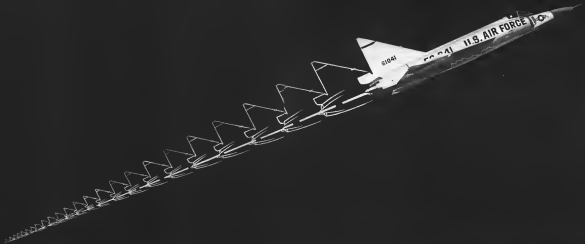
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E-P's sampled data system is a second generation development in the evolution of self adaptive flight control systems. It features digital logic techniques and the concept of continuous self-tuning without the use of external test stimuli. It is flexible enough to meet the requirements of any aerospace vehicle.

Developed by Bendix and supplied to the Air Force under a contract administered by the Flight Control Laboratory,

Aeronautical Systems Division, our sampled data system has undergone extensive analog computer studies using a variety of vehicle characteristics including the F-58 and Dyna Soar. But most important of all, it has flown and flown successfully on an Air Force F-102 over a range of sub and super sonic speeds.

The sampled data adaptive system measures its own performance against model data each tenth of a second,

predicts the error for each succeeding tenth of a second and generates appropriate servo commands to obtain desired aircraft performance. Literally, the system is continuously one tenth of a second ahead of itself.

E-P's system does not require that limit cycle oscillations be maintained. This results in more stable operation with greater pilot acceptance. The sampled-data system also lends itself to multiplexing or time-sharing techniques

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If you have a vehicle that demands the techniques of self adaptive control, you should have the complete details of our second generation sampled data system. It is another example on our list of reliable and complete aerospace systems. For information, write or call East Eclipse-Pioneer Division in Teletown, New Jersey.

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Navy is evaluating Chance-Vought's F8U-2NE Crusader jet fighter for use as a strike aircraft. Above, the swept-back fighter is shown on an evaluation flight armed with two Bulgepops II air-to-air missiles and eight Zuni air-to-ground rockets carried in pods.

## F8U-2NE Evaluated for Fighter-Bomber Role



Above, F8U, which has maximum speed of approximately Mach 2 carries 36 Zuni rockets in wing pods. In flight tests, swept-back Zuni extended far enough to scrub plane's horizontal tail surfaces, top streamline following lines of division and. Below, aircraft armed with Bulgepops and Zuni is parked with wings folded in carrier-storage configuration.



Crusader, powered by Pratt & Whitney J57-P-30 engine producing 15,000 lb thrust, does not look after flight with four 100 lb bombs mounted on multi-purpose pylons under each wing. Note that two-prong wing has been raised for carrier-type landing.



F8U-2NE is delivered with 30 500 lb bombs as underlying pylons and eight Zuni rockets in fuselage launchers. Other equipment carried during evaluation missions included four 20-mm cannons for aerial combat and low-level strafe runs.



Crusader lands at Chance-Vought's Great Point, Tex., facility carrying two 2,000 lb bombs, mounted on pylons under each wing.





## Today's Minuteman will be protected by Tailor-made AAF "Environmental Control" Systems

Deeply buried in isolated launch sites, the Minuteman missiles will strike back instantly, even under direct attack. This is well known. But how can such missiles, with its sensitive guidance elements, remain always operational and ready?

Part of the answer is the Minuteman's environmental support system—prime contractor, American Air Filter Company Defense Group.

A system of heating, ventilating, air filtering, refrigeration, and humidity control may seem commonplace. Yet few firms even felt qualified to bid on this Minuteman assignment. The technical problems were staggering. The reliability of hundreds of missiles was at stake. Also the ability of remote control personnel to survive and relocate.

AAF's capability for such a task had evolved out of four decades of power engineering and large-scale production for military and civilian industry. But even AAF engineers were surprised at the speed with which Minuteman's urgent schedule pushed them beyond previous limits of the art of environmental control.

Component after component was redesigned, as AAF moved inevitably away from the idea of equipment leaving the weapon—to create a necessarily integral part of the weapons system itself.

In completing its part of the system on schedule, AAF's Defense Group utilized its own production plants, plus resources of our Air Filter Division, Temper Air Group (Herman Nelson), Fiber Glass Group (Aeroglass), and other AAF divisions and subsidiaries. This corporate team offers speed, flexibility, and effective systems management capability.

If environmental control is important to your project, and for AAF facilities D-164 Write Defense Products Group, American Air Filter Company, Inc., 215 Third Street, Rock Island, Illinois.



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## EQUIPMENT

### Rubber Spray Used To Build Fuel Tanks

Alcoa—Technique which uses rubber spray to manufacture fuel tanks for light aircraft has been developed by Goodyear Tire & Rubber Co.

Light aircraft fuel tanks are manufactured by spraying a liquid sealant on a cardboard form. Between the layers, liquid nylon is painted and a layer of liquid nylon is laid. The whole unit is then vulcanized and the form removed. In the past, a relatively expensive plaster form was used. Layers of sturdy rubber sheeting and rubberized fabric were utilized. The vulcanizing parts were then cut out and whole unit was not cut out in high pressure steam. After the operation was completed, the form was broken inside the fuel tank and then the plaster pieces were removed through the tank's aperture.



### Portable Oil Pump

Special handoperated portable pump which fills oil to 10 inches during pump. It was designed for United Air Lines' Cessna 441. On the pump, there is a vacuum breaker. Both have been tested by the U.S. Navy. The pump is made of aluminum. Consumption averages only 9 pps per lb. Felt of pump below each light is necessary for pressure oil supply reduction, then having a light advantage than a big click. Minuteman pump was built for United Air Lines by Joe Brown & Associates, San Francisco.



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20-100	4	12	7	4,000	1,500				
30-100	12	18	8	10,000	2,000				
40-100	3	4	2	400	100				
50-100	4	7	4	1,500	350				
60-100	12	14	8	4,000	1,400				

\*Standard bearings are not provided

For Floated Bearing Technical Data write to Dunn Division Dept. 33, 332 Northern Street, Newton 64, Mass.



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## Glass Fiber Cockpit Section Used in C-141

New York—Glass fiber cockpit section for fabrication of flight deck assembly is being used by Lockheed Georgia Co. in development of the C-141 jet freighter. Use of mold instead of punch-by-jaw building method development time for the section is 400%, Lockheed officials say.

Without the technique, development personnel would have had to await construction of the first production hull before beginning preliminary installation of 1,200 electrical wires and 11 sets of wiring, taking control cables and crane facilities.

Technique was devised experimentally for JetStar development, then adopted for the C-141 when it proved to be a practical cost saver and shortened overall scheduled completion dates.

Glass fiber section is obtained from full-scale plastic models of the flight deck hull. Time is saved since shell can be measured in exact proportions, whereas metal must be tested in most instances, according to Lockheed.

Mockup also speeds up finalization of all systems, which can be put along their edges and bent to the hull's contour, eliminating need for a variety of detailed fabrication tools.

**Carlos Rafael**  
Ingeniero en el 45  
años de la  
Revolución Cubana

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PRIMERA EDICION

No. 1, 1961

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## CONTINUAN HOY LAS CONVERSACIONES DE MIKOYAN.

### Cubans Display Wreckage of U-2

Cuban newspaper "Revolucion" prominently displayed photos of wreckage of U-2 high-altitude reconnaissance plane. Cuban reports indicate that the aircraft, piloted by USAF Maj. Rudolf Anderson, Jr., was shot down by Cuban anti-aircraft batteries. Unofficial U.S. news was that the reconnaissance plane was hit by Soviet-supplied anti-aircraft rockets (APR News 12, p. 54). Body of the pilot was returned to the United States for burial. Captain in the newspaper said: "Wreckage of the North American U-2 plane that dove over Cuba while engaged in an espionage mission against U.S. interests was indicated that although Soviet equipment was used to down the U-2, the actual loss was piloted by Cuban troops, adding that U.S. sources believed Soviet technicians were under strict orders not to take action against U.S. aircraft." Lockheed built plane was downed Oct. 25.

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# NEW AEROSPACE PRODUCTS

## Lightweight Ceiling Fan

Coasting fan for electronic applications weighs 1.5 lb and delivers 170 cu ft of air per minute at five delivery



Per is 7 in. in diameter and 2 1/2 in. thick, making it suitable for mounting in any instrument panel; the construction is of anodized aluminum.

Fan has polished stainless steel ball bearings, can be used continuously at any temperature from -57C to +61C. Fan operates at 3,580 rpm, single-phase, 115 v., 50/60 cps, consumes 12 watts. Drive is made of a lightweight poly-carbonate plastic. **Rosen Mfg., Woodstock, N. Y.**



## In-Line Shut-Off Valve

Valve (MV-335) metal gives dependable on-off control of air or oxygen propellants with nearly full line capacity, the manufacturer says.

Valve may be placed in-line flow being used or from a separate pressure source such as a solenoid or by hand. Valve is made of stainless steel and available with O-ring or sliding Teflon seals. It can handle pressures as high as 1,000 psig; the manufacturer says. Solenoid models are 100 v.a.c. and 25 v.d.c. Valve sizes available are 1 in., 1 1/2 in. and 2 in. Models are also available for oxygen service. **Mansfield Valve Corp., Boston, N. J.**



## Center of Gravity Locator

System measures imbalance in X-Y axis directly and allows location of an object's center of gravity to within 0.001 in. on three axes.

System consists of a detecting head and a portable indicating instrument powered by four self-contained flashlight batteries. Detecting head has a crystal measuring surface to which a variety of tips and holding devices can be adapted. Calibration of the system is accomplished by placing a known weight a known distance from the center of the head carrying a precisely known imbalance.

Detecting heads are available in 250 lb., 1,000 lb., 2,500 lb., and 10,000 lb. load carrying capacity with imbalance ranges of  $\pm 25 \pm 100$ ,  $\pm 250$ , and  $\pm 1,000$  in. lb., respectively. **Bates Corp., 50 Bank St., Newton 58, Mass.**

## Presaturation Pump

Aerobase pump (Model 4002) provides clean, dry air from oil and carbon oil situations as high as 60,000 ft for pressurizing airborne tanks and instruments.

Pump is d.c. unit operating on 50 watts at 1.5 amp. Pump is guaranteed to have a 1,000-hr. life, the manufacturer says, and a vibration capacity of 975 cps. in. per sec. **Aero Devco Corp., 8224 Lakeshore Blvd., N. Hollywood, Calif.**

## Wire Welder

Bench-top portable welder made in Mission makes additional fixtures with air wires, thermocouples, fittings, etc.

Unit, called "Mawse," weighs 21 lb. Weld is made by a hand-held "thrust" metal shield like no existing metal shield is achieved by holding the work piece on pliers. From 1 to 5 sec. is needed to accomplish the weld, depending on the thickness of the metal. Respiration heat shield provides heat range for all types of metals.

**U.S. Development, Pine & Rothermel, P.O. Box 30, Hayward, Calif.**

## Ballistic Integration System

Ballistic system (Model SE-100) obtains ballistic data from rocket motor static tests and presents it immediately upon completion of tests of fuel and motor performance and efficiency.



System accepts four channels of input data simultaneously from three or more transducers which it processes electronically to produce a real-time comparison of the integrals of thrust versus time, pressure versus time, and the integrations of the time interval. Readout is via printer and loop back, with provisions for flow magnetic tape, clock, phase and gain pulse output.

System is 45 in. wide, 28 in. deep and 72 in. high and weighs 300 lb. **B & F Instruments, Inc., 1644 N. Lawrence St., Philadelphia, Pa.**

## Cryogenic Quality Meter

Freeze meter gives continuous readout of quality (gas most vapor by volume) of cryogenic fluid at a given point in a cryogenic system. Provisions also are incorporated for operating a strip chart recorder recording measurements, or still readings.

Quality meter gives readings over the full vapor range from 0 to 100% with  $\pm 1\%$  accuracy over the full scale. Meter consists of a pipe section which is inserted into the cryogenic system and an electronic readout that can be remote located.

Applications include: remote fuel analysis; sensitive line efficiency studies; pump erosion studies; and slugging effect studies.

**Space Sciences Inc., 2 Meador Rd., Natick, Mass.**



## Electronic Thermometer

Electronic thermometer gives accurate readings of surface temperatures in 1 to 10 sec. the manufacturer says.

Unit will read temperatures of any component of an electronic circuit as well as point-to-point temperature on heat dissipating devices. Thermometer allows designs to plot graphs of heat sinks and other electronic measurements during development process, thereby verifying calculations without redesigning the final product, the manufacturer says.

Thermometer is available in 50, 100F, 150, 250F, 4, 100C, and 100, 200C ranges. Accuracy is 1% of scale range. Unit is portable, housed in a wooden case and powered by a standard radio battery.

**Electrowest Research Corp., 168 S. Elm St., Claremont, Calif.**

## Purging Unit for LOX Tanks

Mobile purging unit blows heated air through liquid oxygen tanks to cleanse them.



Unit passes atmosphere air through a filter and compresses it to 5 lb. psi. in a centrifugal blower. Discharge air from blower is heated to a 250F minimum and then fed into the liquid oxygen tank by a short length of hose. Tank discharge into the atmosphere. Unit (illustrated) is rated at 10 hp. but special sizes are available.

**Spencer Turbine Co., 450 New Park Ave., Hartford, Conn.**

## Sponge Gasket Material

Close-fitting sponge gasket and seal material called Vespac Sponge is used to give satisfactory performance in corrosive, hydrocarbon and high temperature environments unsuitable for synthetic rubber, neoprene, gaskets and seals, the manufacturer says.



Material resists deterioration of jet fuel, gasoline, hydrocarbon solvents, hydrocarbon fluids, perfluorinated, lubricating oils and greases, and other chemical and corrosive solvents at temperatures of 400F and above, according to the manufacturer.

Material is reported to be well suited to aircraft and missile applications as well as other fields.

**The Chemetron-Hall Rubber Co., 407 East Street, New Haven 3, Conn.**



## Portable Microfilm Reader

Lightweight, compact reader for experiments, teaching, selection in engineering design, on microfilm occupies one sq. ft. desk space and weighs 31 lb. the manufacturer reports.

Called Portabac, Apertec Card Reader, Model MKR, the device projects a 108 in. by 52 in. image on a glass-fronted screen. Reader has five 15 to 1 magnification, angle control scanning lever which permits quick, precise, at magnification range and a from control knob located at head track. The aperture rack is inserted between two glass flats, to prevent scratching and heat loading.

**Recordac, 770 Broadway, New York 1, N. Y.**

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## BUSINESS FLYING



Czechoslovakia's L-60 META SOKOL features a 140-hp engine and a seven-blade propeller. First of the type, delivered in the United Kingdom, is a 140-hp day jet. Meta Sokol A-2 in background.

### Aviation Week Pilot Report:

## Meta Sokol Shows Ruggedness, Stability

By Herbert J. Coleman

Don-Czechoslovakia's four-place Meta Sokol single-engine aircraft is a rugged, easily flown plane especially designed for operation in rough conditions where maintenance could be a logistic problem.

Aircraft, which has been flown since 1956, has been fairly successful as a Czech export item, although given some difficulty due to its great pressure on the engine. It is being phased out of state production but this year, probably due to the engine now being put on the two-engine Morava 200 (AW Oct 26, p 62).

Despite this official position, the Meta Sokol remains favorably with one of its Western counterparts, such as the Cessna 441, in terms of price, delivered in the United Kingdom, is \$12,000 plus tax, according to distributor Peter S. Clark, Oxford Airport.

In line with Czech government policy, the engine has been demonstrated in Czechoslovakia in carrying African supplies and in Cuba and South America. The engine is a four-cylinder four-stroke, which was specially developed for the rough landing conditions found in relatively undeveloped areas.

Another sales factor is the Czech air company has been to maintain a high degree of visibility, especially in the low-out visibility and large safe windows in the sliding canopy. High take-off and also no added for more maneuverability and ground speed.

Aviation Week by this Aviation

When pilot of West Sports Club field, a single propeller about 16 in. from the fuselage of the Meta, was an Oropol demonstrator with Czech registration OK-NM-D. Pilot for the flight was Mikolaj Kocur, of Oropol, the state's export representative.

Value of the engine is not immediately apparent, although its level on the ramp and two variable in ground speed. System also allows the pilot to test propeller, even in rain caused by heavy rainfall at Oropol.

Interior of the Meta Sokol is well appointed and there is considerable leg room in both pilots' positions and in the rear seat. Luggage is stored behind the rear seat.

Weather for the first flight was good, with ground fog patches and wind of about 200 ft. Flight was abandoned after about 10 min of looking for a hole in the clouds. Weather conditions later improved to a 6/10th and

ing of 1,000 ft. Wind was 15 ft from 250 deg and ground temperature of 53°.

Starting the M-512 140-hp engine is simple and consisted simply of turning on starter and ignition switch, adding a few strokes on the primer pump and pushing the starter button. Supercharger is left on for take-off and takeoff engine is warmed up to the usual 500-1,000 rpm.

Usual descent of the Meta Sokol is a button on the control wheel, as well as a push button, which controls the rate of the two-blade Aero V-410 metal propeller. For takeoff, button is depressed in throttle is opened, and prop is rotating at 2,700 rpm.

Takeoff is made at this power setting, with 20 deg of flap extended. The airplane has a tendency to yaw to starboard on takeoff, but this is easily corrected by rudder action. Roll was short, even in the rough-ground conditions and clearance was made at 65-90 mph, using 35 in flap and 2,700 rpm, with supercharger on. Gear actuator (to forward under the wing) is open and is large hand lever between the pilots. Supercharger was cut off at 2,000 ft when power was reduced for cruising at about 130 mph, normal speed for the airplane.

Meta Sokol is responsive to hand handling and has a tendency to hold its position when it is once established. Little trimming is needed, even in steep banks up to 30-40 deg. The Meta Sokol is certified for aerobics, the engine is stressed to 50 with flap re-

### Rolls Engines for Morava

Oropol the Czechoslovakian state export organization, has shown considerable interest in fitting the Morava 200 demonstrator with Rolls-Royce Continental engines to replace the present 140-hp M-512 engine (AW Oct 26, p 62). Primary reason is to increase Morava export sales to the West, which has met overseas resistance because of the question of M-512 speed and pilot availability.



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Count 'em—the channels in Mincom's new CMP-114 Recorder have just been increased from seven to fourteen. Frequency response of 1.2 mc at 120 ips makes this remarkably compact system the only mobile field recorder of its type and size capable of basic FM/FM telemetry and operational protection. Longitudinal recording with fixed heads assures accurate and trouble-free performance. CMP is the first transportable field recorder with six speeds, rewind, push button speed control, dynamic braking, and other advantages of Mincom's exclusive DC tap plate flexible installation. CMP's two major components may be placed in an over/under configuration, side by side, separated, or mounted in a standard rack. Write today for complete information.

**Mincom Division 3M**

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**LATEST VERSION** of the Cessna-developed Tanager Master, fully aerobically balanced and sport plane, is the T-335, which has retractable landing gear. Wing has been stretched one foot over previous models of the aircraft. Gas porting below wing helps to take up support shock in event of a gear up-landing. Tanager Master is certified aerobically with top turbo installed but empty.

Master before moving to more sophisticated aircraft such as McCulloch lighters.

Kocher and the airplane can be equipped with skis for mountain work and has proved quite popular in Canadian countries in a glider tug. It is built in the Montreal Aircraft Factory at Orléansville and has changed very little since its first flight in 1957. From 1957 change was addition of retractable landing gear and a fuselage layout calculated to reduce the wing of the Tanager Master's aerobically capabilities. Wingspan also has been redesigned to take top tanks of container design, and wing on the Zondal has been reworked one foot.

Takeoff from 1000 ft. open field was short, less than 1,000 ft. and Tanager Master was airborne at about 50 mph. Climb to 2,800 ft. was accomplished at about 70 mph and speed built up to 125 mph, the normal operating speed.

There appears to be no limit to sea-borne use of the Tanager Master. On the right, maneuvers included tight loops, a rolling loop, and a double loop. Inverted flight lasting 14 sec. was also made, with no engine cutoff experienced. Cessna has been fitted with a check valve and booster to keep fuel flowing during flights in this position.

Landing will also be quite short and

Tanager Master showed good braking and ground landing characteristics. Fuel approach is flown at between 40-45 mph.

Tanager Master is powered by a Walter Mitter 6-3 cc cylinder installed in low engine which develops 168 hp at 2,100 rpm. Fuel tanks, placed in the wing roots, carry 10 imp. gal. each (12 U.S. gal.). Top tanks hold a total 8 imp. gal. (10 U.S. gal.) and airplane is cleared for aerobically with tanks in-

stalled, but the tanks must be empty. Basic fuselage is of welded frame construction, covered with metal skin, there is some use of wooden stringers for reinforcement. Wing is a semi-monocoque tapered utilizing one main spar and one secondary spar. Main spar carries flying moments, while fuselage moments are transferred to a keelson box formed by the main spar and leading edge members. Tailplane is all metal with fixed rudder tail tab.

## SCIENTISTS AND ENGINEERS

AC Spark Plug, the Electronics Division of General Motors, Research and Development Laboratories in St. Joseph, Colorado, has immediate need for scientists and engineers capable of independent R&D work in the following areas:

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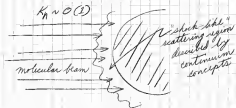
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Length	24 ft. 9 in.	
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Wingspan	30 ft. 9 in.	
Wing area	156 sq. ft.	
Gross weight	2,800 lb.	
Empty weight	1,750 lb.	
Payload	815 lb.	





Of interest to engineers and scientists



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In this study, Douglas scientists and engineers are investigating phenomena in the transition regime between extremely rarefied and continuous regimes of hypersonic flow.

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**CONTROL SYSTEMS:** Background in aircraft knowledge as related to the field of control systems with a knowledge of test systems and design tools preferred.

**NEW DESIGN:** Background in mechanical design, analysis of structural, mechanical components, bearings, and design of performing preliminary stress analysis.

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**FLIGHT TEST MAINTENANCE DESIGN:** Design, layout, and schedule flight test and maintenance. Magnetic tape, data analysis and tabulating experience required.

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Two major task areas are of special interest:

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This branch analyzes existing or proposed space system designs and operational characteristics to establish system requirements and feasibility for developing design concepts. It includes those activities:

**Availability**—associated with dynamics and trajectory analysis, aerodynamic heating, staging studies, aerodynamics, a full flight evaluation.

**Preliminary Design**—establishes configuration feasibility to meet mission changes and future missions as dictated by program requirements.

**Future Systems Analysis**—studies advanced systems with identification of tradeoffs between various parameters as well as projected availability of new and higher performance hardware.

### PRODUCT IMPROVEMENT

These programs provide for assignment involving the investigation of the structural, material, and materials disciplines including complete or partial feasibility studies, design, development, analysis, and testing. Tests also are involved in the areas of electrical systems, instrumentation, and action and checkout. Component product improvement tests will be performed to correct design deficiencies and program deficiencies detected in the evaluation and test programs.

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We are also seeking Marine Engineers for work on marine vehicle applications. The nature of these programs provides ample opportunity for individual expression and progress.

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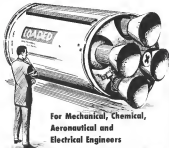
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#### Test Engineers

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### OTHER IMMEDIATE OPPORTUNITIES

#### Cost Engineer

Experience in job cost estimating for large complex and, sensitive, rocket motor and fuel gas systems. Must have degree or equivalent experience in business administration, accounting, economics, engineering or related field.

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Interested applicants are invited to write to: **Mr. Bruce E. Sullivan**, Personnel Department, Aerothermo-Dynamicists, Inc., 1000 N. 1st St., Suite 100, St. Paul, MN 55101.

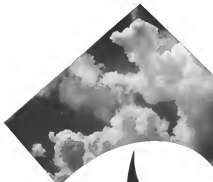
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## A futuristic space station or shuttle is docked near a large, cratered planet. The station has a blue and white color scheme and a large, glowing orange and yellow section. A bright light source, possibly a star or a distant planet, is visible in the background, creating a lens flare effect. The scene is set in a dark, starry space.

F. W. Stern, Inc.  
President  
Kearney Division, Inc.

... that the TVA system involved only a minor concern. The issue is a responsible repair. The nuclear industry like catastrophic accident. It is in this case the mandatory inspection and possible removal from service which had previously proposed bill on

ally, he states that "the flight engineers, even with severely limited experience (65 hr on 700 equipment), should perhaps have been able to maintain the relatively simple to read, and limited number of checks."

By itself it might be argued, the 'clade' is not a two-class percent type display. Indeed such shortcomings I shall return to shortly. But first, let us consider the overall structure and content of the display. The background of the region parameters—old percent transposon, and quarter—can be located on the extreme right side of the right raguard's panel. Therefore, to conduct the initial information displayed by me, we can compare the quarter map with the transposon map. The quarter map is a 100% scale, and the transposon map is a 100% scale. The quarter map can also display good without completely opposing the other. Thank God, a few of the railway have finally come to their senses as displayed in the output listed in the Legend: C100. It is really the only one of the two but it is hard to read since the map is not a two-class percent type display.

Mag. Rindler is of the opinion that the machine time of the crew was too slow in this emergency, and stated " . . . that things had to be accomplished quickly in as even more professional manner than back on the shore."

The attitude of want, which includes the FAA, is one of "how me the better and I will not, until then don't bother me, I have too much work to do."

CLARENCE B. IVINS  
Vice President Engineering, FEUN  
Washington, D.C.

[illegible]

As an interested and qualified observer of the actions of pilots of commercial airlines today, I stand behind them 100% when any attempt is made to undermine the confidence and respect due them for the service they provide.

Alan Weissmann, Flight Engineer  
Pan American World Airways  
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fluorescence hadn't been refined. Fluorimetry locked in theory (as far as rocket engineers devised ways to show it was

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er that's packed      and at present's on

Now fluorescent can be made from materials that don't

The most powerful has high density (specific) and high thrust range and physically ignites with

handling liquid  
over energy was  
as good as Ball  
and it took a



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